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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

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JULY, 1940

No. 1

Agricultural Research in India

THE Imperial Council of Agricultural Research concluded its ninth working year on 31st March, 1939. The annual report for the period 1st April, 1938 to 31st March, 1939, which we received a few months back, gives as usual an account of the large amount of useful researches and other activities conducted under its aegis. The Council financed 122 schemes employing about 350 scientific workers and spent more than 16 lakhs of rupees. We are glad to note that a cess on agricultural exports has been imposed; this will improve the financial position of the Council. The annual report serves as a handy reference to the various activities of the Council. There are also three journals, mainly for the scientific investigators, published by the Council and recently a popular monthly journal "*Indian Farming*" dealing with the subjects in a more elementary way has been added to the list. It is not, however, easy to form an idea of the actual progress of the schemes from the annual report and the journals. The report in itself does not seem sufficient for the purpose. When we consider the vast areas and the wide divergences in climatic and soil conditions with their special problems, the colossal losses caused by erosion, by leaching by water, by extractive farming, by the soil-depleting crops, and the backwardness of our agricultural practices, one cannot but feel that the time has come for the Council to review the whole position and evolve more definitely a policy of its own and advise the Government accordingly.

Steps should be taken to ensure a more energetic and better co-ordinated drive all along the front, with a view to the elimination of the weak spots in the present organisations in the Centre and in the provinces for research, education, advisory work, and propaganda, and remodelling all these activities in the light of experience. Through the efforts of the Council, a framework of agricultural research has been built up and the experience gained should now enable it, with the help of its own resources, of the provinces and of distinguished non-official scientists, to draw up a comprehensive programme. The public as well should be kept better informed of the present position, the problems and the possibilities of their solution. Every year useful information and data are collected and it seems to us that separate periodical reviews of this stock of information and the progress made in the separate schemes will be very helpful. These reviews need not be published annually, but every three or five years, and should contain a clear statement of the problems and the progress and achievements made so far. We are sure such reviews will be much appreciated by the general public. They need not be merely popular expositions but should be accompanied by a summary in non-technical language. The inclusion of accounts of the work related to the major schemes which have been done elsewhere will materially enable technical and non-technical men to appraise our efforts and achievements as far as their essential value is concerned and will also stimulate the research workers themselves. This will involve merely an elaboration

of the present method ; but will offer an opportunity of assessing the progress of the schemes far more adequately to decide on their continuation and improvement. We are quite aware that this procedure may mean an increase of staff in the publication section and will also require men properly qualified to sift the results and to collect information contained in relevant publications. But this sort of survey is expected to be of such material help to the Advisory Board, the standing committees and the research workers that we have no hesitation in recommending the suggestion for the serious consideration of the authorities. It is not intended that the work of the Imperial Bureaus should be duplicated. The reviews should deal with the major subjects for investigation, e.g., rice, jute, cotton, sugar, irrigated lands, reclamation of lands, soil research, manurial trials etc. with special reference to Indian conditions and should make a comparative study with what has been done elsewhere.

From several points of view, it is desirable that research workers working under the schemes scattered all over the country studying isolated problems should meet periodically and exchange notes. The meetings of the Advisory Board, of the Board of Agriculture as also of the Indian Science Congress and the Indian Society of Soil Science offer some opportunities in this direction. But the time which can be spared for a fruitful discussion is insufficient and the atmosphere on these occasions breeds a sense of haste which does not conduce to thoughtful scientific work. Besides, agriculture is a field science and a detailed experience of field conditions obtaining in different parts of the country is essential. Most of our scientific workers have little chance of keeping themselves in touch with the progress of the work done outside their own province or laboratory. Newer techniques and methods of theoretical approach are being continuously developed and it is necessary that our workers should have an opportunity to discuss these and to see such work as is going on in the university and other laboratories. University men interested in agricultural problems should also have opportunities of gaining field experience. A periodical conference of research workers in different parts of the country with a well-defined purpose will be helpful in this direction and non-official representatives of pure science, who are engaged in allied problems, should be invited to participate in the discussions.

At the meetings of the Council, of the Advisory Body and the special *ad hoc* committees, held for the

purpose of supervision and guidance of the workers no serious thought can be given in the short space of time allotted for the purpose to the very lengthy agenda. Excepting the ordinary administrative details, the members do not find sufficient leisure, nor are they in a position to marshal sufficient materials to enable them to make substantial contributions to the discussions. The work of the Council has expanded enormously and a thorough scrutiny and co-ordination of all activities is not possible at the periodical meetings of the Advisory Board. It is essential from the point of view of the utility of the work that there should be a harmonious co-ordination of the different aspects of related studies. It seems to us that the present technical expert staff is having a tiring time in carefully analysing the increasing number of schemes. They would be gradually so preoccupied with their specific branches that for the profitable co-ordination of the schemes they should soon be provided with additional expert help and, if necessary, from outside. We suggest that the close co-operation between the university staff and the technical staff under the employment of the Government of India which is already bearing fruitful results may be immediately extended for this purpose. In addition, a small advisory committee consisting of the experts of the Board and of non-official scientists should be constituted to help in this co-ordination. The Advisory Board itself is too unwieldy to effect this and a standing advisory committee for purposes of co-ordination would best meet the situation. This committee should meet continuously for a number of days before the meetings of the Board and prepare a memorandum on the schemes, their progress, etc., for the consideration of the standing and the *ad hoc* committees. This committee will again meet immediately after the standing and *ad hoc* committees have finished their deliberations to prepare a digest for the Advisory Board. The function of this committee will be advisory and it will naturally relieve the Advisory Board of a great amount of strain. This committee should have the power to suggest to the Advisory Board new and alternative schemes and to advise it on questions of policy. It is expected that this committee will be able to give a greater impetus to fundamental research and will always keep definite objectives in front of the Board. The Council through this committee may be in a position to arrange for detailed discussion with workers in different localities.

Sometimes the programmes in the different government institutes and research laboratories show a tendency to be stereotyped. Standing committees with advisory functions, as suggested above, having non-official experts may be similarly in touch with the work of the sugar, cotton and jute committees. There is unfortunately very little co-ordination and co-operation between the research laboratories of these committees and those of the universities. The standing committees for these will be able to give valuable advice and guidance and the Advisory Board is sure to find their work most helpful. We do not think it will cause friction and undue interference. The suggestions made above that the committees will have advisory functions will protect the institutes concerned from such difficulties in their work. The method of securing non-official experts on these committees should be such as not to lead to wire-pulling of any sort and the best men should be nominated by the Advisory Board itself. We are sorry to note here that there is at present no close contact between the research laboratories of the Central Jute Committee at Calcutta and the universities at Dacca and Calcutta. We are afraid some of the resources of these Universities are not being utilised to the best advantage for the furtherance of the objectives which led to the foundation of the Central Jute Committee and its research laboratories. An advisory committee in this case may consider the existing facilities in the different laboratories and suggest which work may be offered to each of them, by providing extra facilities, if necessary.

The proposed technical advisory committee under the Board in co-operation with other standing advisory committees will be competent to assist in co-ordinating under a sound comprehensive policy not only the different schemes and the activities of the research institutes but will also be in a position to give advice to the provincial departments of agriculture wherever necessary. The best scientific methods must be applied to the problems and in carrying out the work it is always necessary to see that resources in men and laboratory facilities are utilised to the best advantage. We are afraid that at present there is too much of work in isolated compartments and this seems to be very common in institutions financed by the Government. The administrators at the top too often find it rather perplexing to come to a definite decision on technical matters and on the merits of proposals. The proposed advisory committee, if well constituted, should be of a great help to them, and if the present staff and

the financial resources of all these laboratories are brought in line to fit with the major development schemes, the chances for a quick solution of the different problems that are facing us will materially increase.

Crop production and financial prosperity of the cultivators should constitute the objectives of the research activities financed by the Council. For this purpose, the conservation of the soil and its fertility should be optimum and balanced. One of the functions of the proposed technical committee of the Advisory Board should be to classify the existing schemes and point out their relationship to definite objectives whenever necessary. For purposes of classification of research schemes it will be worth while to follow the system given in the *Report of Agricultural Research in Great Britain* by the P.E.P. which we reviewed in this journal in the issue of May, 1939. It is given below and we make no apology to quote in length the references to activities which must supplement research.

(1) "Background research into fundamental scientific laws underlying all agricultural and industrial enterprises which should be carried out under the auspices of the universities.

(2) "Basic research into broad subjects with a pronounced practical bearing to be done by research institutions.

(3) "*Ad hoc* research into special problems to be mainly done by research institutes, though a considerable amount may be done privately.

(4) "Pilot or development research to bridge the gap between laboratory experiments and commercial practice which can be undertaken by research institutes, colleges, farm institutes and private farms.

"To supplement these activities there should be

(a) information service with provision for a continuous pooling of data between research workers, and the dissemination of research results among agricultural advisers and instructors,

(b) extension work comprising spreading of scientific knowledge amongst farmers and reporting the farmer's problems back to the scientists,

(c) Public relations work to interest the public and the farmer in the research activities by means of films, broadcasting and other methods of mass publicity, and

(d) training facilities for equipping the personnel both for future research work and for key posts in all the agricultural services."

Much spadework is yet to be done in

- (1) Better control of water supply for crops ;
- (2) Prevention of partial stratal loss of silt by erosion, by leaching by water, by bad methods of management, by faulty irrigation, etc. ;
- (3) Provision of better implements ;
- (4) Better system of crop-planning, in particular, of better rotation ;
- (5) Evolution of varieties suited to different climatic and soil conditions ; and
- (6) Improvements in the methods of soil management and manurial treatments. In this connection, a more detailed and up to date knowledge of our soil is of prime necessity. The manurial trials and the improved varieties have to be correlated to the types of the soil where the crops are to be grown for better returns.

At the invitation of the Government of India Sir John Russell, whose vast and authoritative

experience is widely known, made a study of the position of agriculture in this country, and submitted his report a couple of years ago which *inter alia* suggested certain measures. These measures concerned mostly the developmental side of the work of the Council. The public are not aware what steps have been taken by the Council and by Governments in respect of his recommendations. His recommendations should not be allowed to be forgotten and pigeon-holed in the Secretariat. The scope of the Council's work now requires more broadening on the developmental side. The stage is ripe when reorientation of Council's activities should be made and the idea that agriculture is purely a branch of technology, where new knowledge is not necessary, should be modified. It is also high time that along with the improvement of our primitive agricultural practices the recommendations of Dr Wright in connection with the dairy improvements should be given earnest consideration.

VEHICLE FOR SWAMPS

MANY of the oil and geophysical companies operating in the Gulf Coast areas, where swamps abound presenting transportation difficulties, have not been satisfied with being baulked by nature. This has led to the development of the "marsh buggy", a truck or conveyance which can carry a heavy load over hard or soft ground or through water. After examining the methods used by other seismograph parties, the Stanolind Oil Co. has developed a marsh buggy which will travel with equal ease in water or on land. After it has finished work in a particular area, it can be disassembled into three parts and carried to the scene of its next operation on a truck. This buggy has four wheels but they are also pontoons, being made from sheet steel and hollow on the inside except for bearings and braces. Each wheel has a drain plug and a plug for greasing the bearing. All of the wheels are 4 ft. wide at the axle although the back ones are tapered to 3 ft. in diameter at their circumference. The wheels are 9 ft. in diameter, the front ones being equipped with lugs made from 4 in. angle irons for driving and the back ones having an arched surface with a steering rim on them. The Stanolind marsh buggy is 21 ft. overall in length and 15 ft. in width ; the wheels, frame, motor and transmission weigh approximately 9,000 lb. It will carry a useful load of 6,000 lb. when it is put in service. Despite its weight it will climb hills, travel at 15 m.p.h. on land and approximately the same speed through water, regardless of depth. Steering on land and shallow water is through the back wheels. In the water the front wheels are used to steer. It is extremely manoeuvrable in both.

Problems of Irrigation

N. K. BOSE

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TO talk about irrigation in this country one is led to the province of the Punjab, the land of five rivers. The peculiar geographical position of the Punjab makes it the premier irrigation province of India. On the north it is bounded by the snowcapped mountains of the Himalayas from whose glaciers all the five rivers of the Punjab derive their supply. During monsoon the rivers are mostly in flow which passes off rather quickly and by the middle of September the rivers are low. There are heavy rainfalls in the mountains and the foothills, which fall off rapidly as one goes south into the plains and by the time one reaches the tracts round Lyallpur the rain is not more than 10 or 12 inches per year. Even this scanty rainfall is not properly distributed all throughout the year. When valuable crops such as cotton or wheat are to be matured, there is seldom any rain so that these crops can hardly be raised on rainfall alone. Hence during pre-irrigation days most of the country looked like deserts, only riverine tracts were cultivated.

Before the British came to the Punjab there were a few canals which were mostly of inundation types. Feroze Shah Tuglak dug a canal from the Jumna to feed Hissar and the districts round Delhi. This was in the 14th century. In the 17th century Ali Mardan Khan, the great engineer-general of Akbar and of Shah Jahan, dug Hasli canal from the Ravi to feed the Shalamar Bagh of Lahore. Later Ranjit Singh dug another canal from it to supply water to Amritsar. Besides these there were a number of smaller inundation canals taking off from the Jhelum. They supplied water to tracts near Shahpore. There was also well-irrigation, but this could only be practised near the rivers as the subsoil water in the Punjab is mostly saline and not fit for irrigation. This was the state of affairs when the British conquered the Punjab in 1849. It is well

known that in the early days of occupation of the Punjab by the British, the Sikhs were always giving them trouble. In order to pacify the Sikhs, attempts were made to make them settle down on lands for cultivation. Hence canals were dug and irrigation started. The old existing canals were first renovated and one of them was the Western Jumna Canal taking off from the foothills where the Jumna emerges from the Himalayas, and another was the Upper Bari Doab Canal taking off from the Ravi at Madhopur. In 1890 proposals were first made to build a new system of canals.

Cultivation by artificial irrigation has been practised in India for many centuries before the advent of the British in India. Eminent engineers like Wilcocks and others are of opinion that the systems of waterways in the deltaic region of Bengal and in the Tanjore District of Madras were originally artificial channels taking off from the Ganges and the Caverry. These systems of irrigation were not however perennial. Another system of irrigation built dams in hilly tracts and created vast reservoirs of water during rainy season from which supply for irrigation could be had when monsoon was over or rains had failed. Examples of such reservoirs are now found very frequently in the hills such as the Dal Lake in Srinagar. In a third system of irrigation water was drawn from wells. It was generally practised in riverine tracts and is still being done in the Ganges and the Indus Valleys.

IRRIGATION BY WEIRS

It had been said earlier that some of the pre-British period canal system had been renovated and made fit for perennial irrigation. Previously they used to be mostly inundation canals, these canals used to run full supply when the river level was above a certain point and water could be thus forced into the canal due to some natural obstructions such as boulder or shingle bar on the bed of the river.

* Adapted from the first of a series of lectures delivered before Calcutta University in August, 1939.

At other period when the river supply used to be low these canals did not carry any water. But with the present type of weirs or barrages it is possible to feed the canal system even in winter when the river supply is very low—sometimes it so happens that all the water available in the river is taken into the canal and the river bed below the weir runs dry. The advantage of such a system of control is obvious, and such structures known as "Indian type" of weirs are now being built in America and other countries also.

The first weir on the new lines was built in 1890 on the Chenab at Khanki. Before any irrigation was opened in this *doab* between the rivers Chenab and Ravi, there used to be very little cultivation done in this tract—lands looked mostly like deserts and the population then was only seven per square mile. The present population in this canal colony known as Lyallpur Colony is 350 to the square mile. This area is now one of the most prosperous colony in the Punjab, yielding a land revenue well over 2 crores of rupees. It is fed by a system of canal known as the Lower Chenab Canal. This system of canal has presented to the engineers almost all the problems that can conceivably arise in dealing with irrigation.

If we look at a map of the Punjab, we will find the river Chenab on which there is Wazirabad, an important railway centre. A weir or masonry bund had been put up ten miles downstream of the river

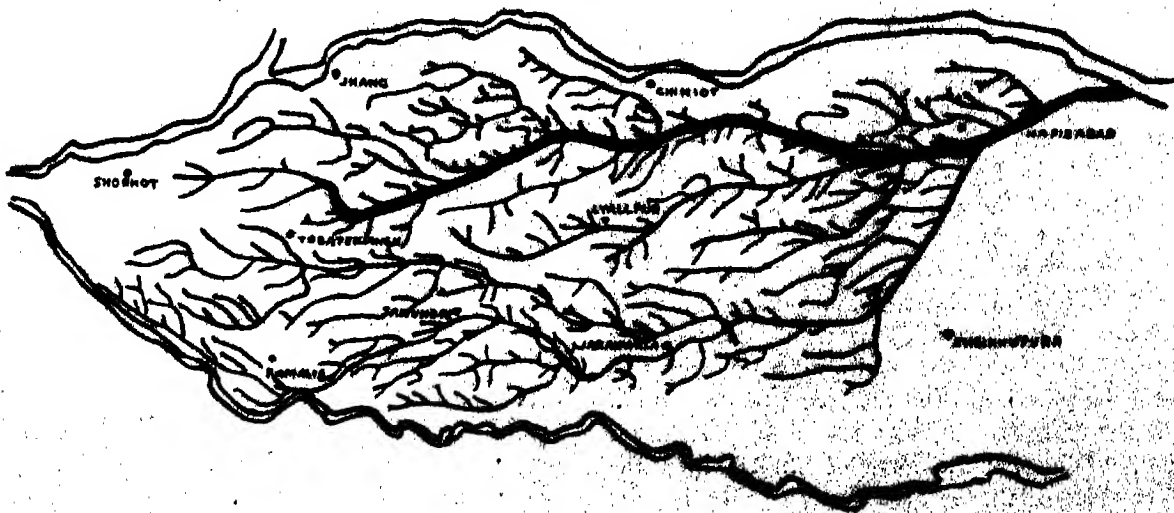
number of spurs in the river called as A, B, C, D, E, F, G, H, I and J on the plan. These were constructed after the weir was built. The original

PLAN SHOWING
HEADWORKS AND TRAININGWORKS
LOWER CHENAB CANAL
AT
KHANKI



course of the river was between the spurs I and J. According to the practice in the Punjab, the weir was built in the dry in its present position and

LOWER CHENAB CANAL



to head up the water supply in the river upstream of the weir site. It will be seen that there are a

subsequently the river was diverted over the weir by closing its original course. This practice has to

advantages and disadvantages. The main disadvantage is that after the construction of the weir the problem of river control becomes very important and lakhs and lakhs of rupees are spent in keeping the unwilling river to its new course. At Khanki one can see an array of spurs, some of them are due to the fact that the Upper Jhelum Canal drops a considerable supply of water from the Jhelum to the Chenab at this point, while others were built to train the river on to the weir. In spite of such heavy battery of spurs, the river at Khanki is still a source of anxiety and expense. In 1932 a heavy flood visited Khanki and due to unusual concentration of discharge in bays 4 and 8, heavy damage occurred necessitating extensive repairs costing about 25 lakhs of rupees, and loss of revenue due to closure of this canal on account of the failure. The weir was reconstructed during 1933-34 according to the latest engineering practice; for greater flexibility of control, bays Nos. 4 and 8 were fitted with gates and the crests of the weir in the bays were lowered by 12 ft. By this means it was thought that the river could be diverted to the left, right or centre of the weir as desired. In practice this has not been possible. It will be seen that the river approaches the weir along two channels, the right channel and the left channel. During 1936 the right channel was so much developed that in the following winter great difficulty was experienced in feeding the canal from the left channel and the level of the crest of the weir had to be raised by temporary bunds to bring water to the canal from the right hand channel.

CONTROL OF SILT

The problem of river control is intimately connected with the question of silt entry into the canal. Coarse silt is harmful to a canal system in more than one ways. If it goes to the water-courses it is harmful to the fields, and if it settles in the canals it requires frequent clearance, otherwise bed levels of the canals will go up and banks will fall down necessitating heavy repairs. So that harmful silt has to be excluded from the canal before it can enter it, or ejected after it has entered. Exclusion at the point of the river where the canal takes off is generally effected by controlling the river, or by constructing some types of silt excluders. These excluders are built on the principle that heavy silts are normally found on the bottom layer of a volume of flowing water. When a weir is built across a

river, the portion of the river that is nearest to the canal is separated from the main river by a long divide-wall sometimes extending 700 or 800 ft. upstream of the weir. The area enclosed between the divide-wall and the bank of the river where the canal takes off (which is known as the Canal Regulator) is called the pocket, and the portion of the weir that is thus cut off is called the Undersluice. The Undersluices are generally provided with gates so that supply into the pocket in excess of the requirement of the canal can be regulated. When the river water enters the pocket, its velocity is gradually reduced and heavier silt deposits on the bed of the pocket, and comparatively silt-free water enters the canal. By this means silt goes on accumulating in the floor of the pocket and sometime so much is heaped up that it gets drawn into the canal. At this stage the Undersluice gates are opened and the canal regulator gates closed and the pocket is flushed. These are known as sluicing closures. They are rather inconvenient during period of keen demand and cause some loss of revenue. In order to avoid these closures various types of silt-excluding devices have been tried in models and in the river. There is another method in which silt is allowed to enter the canal at the river head but after it has proceeded 2,000 to 3,000 ft. down the main line it is extracted along with the bottom water and sent back to the river.

Thus river training is not only useful in controlling the river and preventing it from attacking the weir, but it can also be useful in regulating silt entry into the canal. Such experiments on models of the Khanki Weir are being carried on now, and already a sum of Rs. 12,000 has been spent on these experiments. But considering the importance and magnitude of the problems the Punjab Government is prepared to spend much more. The very existence of a colony which brings in a revenue of over 2 crores depends on this headworks. It has been mentioned before that this headworks was repaired after 1932 flood at an expense of 25 lakhs of rupees. Due to the flood of 1932, serious damage to this headworks was discovered in bays 3 and 4. A boatman stumbled into a hole on the downstream side of the weir and this gave a clue to the damage. The soil below the floor of the weir was all washed away leaving a hollow of about 900 cubic feet capacity. One of the characteristics of these weirs is that they are built on sand so that where the masonry structure ends water comes into contact with the sands of

SURFACE FLOW

Position and magnitude of these blocks and arrows are fixed after model experiments which in the case of the Anderson Weir cost about Rs. 350/- in actual material used. If we consider the overhead charge of the laboratory staff it will come up to Rs. 5,000/-. If these experiments were carried out before the construction of the Damodar Weir, the

Bengal Government would have been saved the expense of Rs. 10 lakhs in repair.

The above gives an idea of the problems that engineers are likely to come across while building and operating weirs on sandy river bed. These are: (i) River Training, (ii) Exclusion of silt, (iii) Protection against uplift pressure, and (iv) Protection against downstream scour.

All the problems refer to the headworks, that is, the position of the river where the weir is built and the canal takes off. It is the most important unit of a canal system and is most carefully and zealously looked after. We know something about problems (iii) and (iv) but very little about (i) and (ii). Extensive experiments are being carried out in India and outside to solve these problems.

IRRIGATION BY DAM

Irrigation is also carried out by drawing water from reservoir dams. Dams are generally masonry structures constructed in a gorge as a river flows through it in a hilly country and the river water is



BOULDER DAM

collected in a reservoir from which supply for canals may be taken off. The Boulder Dam of America, is the biggest dam so far built. It has got an overall

height of 527 ft. The capacity is such that if all the water that it contains be spread over, it will cover 30,500,000 acres of land to a depth of one foot. Part of the storage facilities of the reservoir are intended to assure a dependable supply of water for irrigation purposes to the Palo Verde Valley near Blyche, California, to the Yuma (Federal) Project near Yuma Arizona, and to the Imperial Valley in California. The remainder of the storage may be used to furnish an assured source of water supply for the cities and towns in Southern California to help by irrigation the development of lands in Arjona, California and Nevada.

The upper 9,500,000 acre feet of the reservoir volume will allow control of floods of the magnitude of 200,000 cusecs above the dam to 48,000 cusecs below; and a flood of 300,000 cusecs (probably the largest flood in recent times) to 75,000 cusecs. Apart from the question of water supply for irrigation purposes and also of flood control in the Colorado river, the dam had been equipped with power plant designed to furnish 1,600,000 to 1,800,000 horse power of installed capacity. This will make available four and a third billion kilowatt horse power annually upon completion of the dam.

In India there are at present very few dams of good magnitude. Muthra Dam, Krisnaraj Sagar Dam are worth mentioning. In these types of dams generally known as Gravity Dams, the theory of elastic stress and strain had been extensively applied. In complicated structures mathematics had failed, and recourse had to be taken to model experiments depending on stress function and photo-elastic properties of models. It has been possible to analyse many intricate cases with the help of such models at comparatively small cost. Considering that failure of such a dam may entail the expenditure of a few crores of rupees, and risk of life and property over an extensive stretch of country, such model experiments are nowadays essential features of dam construction.

IRRIGATION FROM WELLS

Another method of irrigation is by taking water from wells. This is the most primitive method of irrigation. Recently scientific methods have also been applied here. In U. P. the Ganges Valley Tube Well Scheme is a well-thought-out and extensive scheme that is revolutionising the old method of tube well irrigation. The Ganges Canal in the first hundred

miles of its length passes through a rapidly-falling steep landscape. The canal is brought down to the general level of the Ganges Valley by a number of falls. These falls have been utilised by the present scheme and electric current generated. These currents are distributed in small units to villagers, who use them for pumping water from tube wells for irrigation purposes. The Scheme is still in its infancy and nothing definite about its prospect can be said at this stage.

To carry water from the river or the tube well to the fields, canals form the connecting link between them. In almost all cases canals are dug, or constructed in earth and generally follow the slope of the country. Canals are so designed and aligned that they run along the ridge of a countryside so that supply to the fields is simply by gravity flow. If the canals strictly followed the slope of the country the water-level in the canal would not be much higher than the level of the fields that are to be irrigated. Hence the slope of the canals is maintained slightly flatter than that of the country, and after 10 or 15 miles, depending on the difference between these slopes a sudden drop is given in the bed of the canal and the water is carried from the upper part to the lower portion over a masonry structure known as Falls. The drop in the bed level which is the same as the drop in the water-level varies from 2 to 3 ft. and 12 to 15 ft. In going down this fall water attains very high velocity and a standing wave is formed at the downstream end of the fall, so that all the difficulties of a standing wave are encountered here also. Remedies are more or less the same as in the case of the river, but in this case there is this complication that as the sides of a canal are generally artificially formed they cannot stand the side action of the standing wave, and just below a fall the side-scours are very troublesome and increase the maintenance cost of a canal. Extensive experiments in models are being carried out to prevent these side-scours.

SILT PROBLEM

It has been mentioned before that elaborate precautions are taken at the headworks to stop the entry of coarse silt into the canal. By this means very coarse silt can be excluded but some coarse silt does get in and the canal has to be designed in such a way that this silt will be carried by water in the main line and branch into the water-course. Attempts have been made by empirical methods to arrive at a satisfactory solution of the problem. It

has been long recognised that silt plays an important part in the economy of a canal system. In spite of very rigid regulations at the headworks the canal engineer finds that the canals are silting up badly and thereby losing command, or the berms are falling in rapidly widening the channel and thereby threatening breaches along the line. The amount of money spent on silt clearance and repairs due to silt troubles is considerable on a canal system whose success depends on the degree in which the ill-effects of the silt can be overcome or obviated.

Regular observations of hydraulic data are being carried out in the Punjab in channels that are known to be in regime. These consist of discharges, velocity, cross-section, slope, bed silt sample and water temperature. These data have been statistically analysed and various relationships have been obtained which are being tested in other channels in the Punjab.

Another line of attack has also been started in the Irrigation Research Institute. It is well known that the flow in a pipe or a canal depends on the characteristic of the boundary and the velocity distribution depends on the nature of the boundary. Prandtl and Nikuradse have shown this to be the case for both smooth and rough pipes. It has been possible to show in the Lahore Institute that the same law holds for flow in canals. It is proposed to correlate the characteristics of the bed material with the velocity distribution in the canal and thereby to arrive at a solution of the problem of flow in alluvial channels.

WATERLOGGING AND SALT EFFLORESCENCE

Though the problems that I have dealt with up till now are of great importance for an irrigation engineer and may cost the Government lakhs and lakhs of rupees yet they pale into insignificance when one considers the question of seepage water from canals and consequent waterlogging and salt efflorescence of the countryside. Wherever in arid or semi-arid countries perennial irrigation has been practised this menace of waterlogging and salt efflorescence has threatened the very existence of the whole system of irrigation and thereby the very prosperity which irrigation had called forth. America and Egypt are going through this stage and the Punjab had been no exception to this. As water flows through channels dug into the earth, considerable amount of it seeps through the bed and the sides and goes to the water-table to raise it. If the

addition goes on, the water-table rises continuously and comes up to the natural surface and forms ponds and marshy lands breeding malaria carrying mosquitoes. It sometimes happens that as the water-table rises it passes through soil strata that may contain harmful soluble salt. As the water-table approaches the natural surface evaporation draws up salty water from the water-table and leaves the salt on the ground surface. It frequently happens specially in the Punjab that as the water-table rises it touches a layer of hard clay which in certain cases may extend to 20 to 25 ft. from the natural surface. If this soil crust contains harmful salt then capillary action which is very strong in such soils starts the movements of moisture from the spring level and brings the salt up on the surface.

Various methods are being tried in the Punjab and elsewhere to combat these evil effects of the rise in the water-table. One of the methods is to line the canals so as to make them impervious. This is an expensive method but the saving of water that it will bring and the partial relief from the evils of waterlogging that will result has made the method financially possible and the Punjab is going to try it on extensive scales. Various other methods are being tried and efforts to reclaim the lands that had already gone bad are ceaselessly going on. The Punjab Government is not sparing any efforts for this as the prosperity of the province depends on the solution of this problem of waterlogging and salt efflorescence.

EARNINGS ON COLLEGE EDUCATION

RANDOM reading among recent statistics yields the information that in 1936 the average earnings of an American employee amounted to \$1,244. In that same year college graduates (male) only a year in possession of their diplomas had averaged \$1,300, and the analysis by the United States Office of Education—which had disclosed this fact—also pointed out that girl graduates a year out of college had averaged about \$1,100. Men who had been out of college eight years in 1936, however, were getting \$2,400 apiece, while their women colleagues could average only \$1,600.

For those college alumni who had spent eight years struggling for a living and whose status was known to the Office of Education, it appears that engineering and research paid about as well as general business—that is about \$2,500 a year—but not so well by a matter of \$500 as medicine or the law. A previous and unusually comprehensive survey confined only to engineers and made by the Bureau of Labour Statistics showed that in 1929—a year when 6.4 per cent of all incomes in the country exceeded \$4,000—graduate engineers with ten years' experience obtained from \$3,600 to \$4,600 in the various branches of their profession, and that the median income for all engineers was \$3,400. By 1934, however, the median income had shrunk to \$2,300.

Vitamin K*

SACHCHIDANANDA BANERJEE

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WHILE working on fat metabolism in chicks, Dam (1929) observed that the diets deficient in certain respects gave rise to a disease resembling scurvy. This was not due to the absence of vitamin C in the diet as vitamin C could not cure this haemorrhagic disease. Dam later observed that newly hatched chicks, fed on a diet containing all the essential food-stuffs but deficient in certain fat-soluble materials, suffered from a fatal haemorrhagic diathesis characterised by bleeding from the pinfeathers, haemorrhages into the subcutaneous tissues and muscles and gizzard erosions. This condition could be cured or prevented by administration of the non-saponifiable, non-sterol fraction of hog liver fat or by feeding alfalfa. This anti-haemorrhagic principle in different food substances was termed by Dam vitamin K or Koagulationsvitamin. Almquist and Stokstad (1935) working independently of Dam simultaneously described the same haemorrhagic disease in the chick, which was cured by feeding alfalfa, a very rich source of the vitamin. Schonheyder (1935) observed that the haemorrhagic tendency was due to a prolonged clotting time associated with a deficiency of prothrombin content of the blood. Other constituents of blood taking part in blood coagulation, namely fibrinogen and calcium, were not altered.

SOURCE OF THE VITAMIN

Green leaves are very rich in vitamin K. Alfalfa, cabbage, spinach are very good sources of vitamin K; cereals and carrots are poor sources, while potatoes, lemon juice and cod liver oil are practically devoid of this vitamin. The vitamin may also be prepared from fish meal, rice bran or casein after the extracted material has been allowed to putrefy, bacteria apparently affecting the synthesis of the vitamin under such conditions. Almquist *et al* (1938) have isolated a fish meal organism closely resembling

bacillus cereus, which contains and is capable of producing in fish meal considerable amounts of vitamin K. Vitamin K is also present in *bacillus subtilis*, *staphylococcus aureus*, *bacillus coli* etc. Vitamin K may also be produced by bacterial activity in the intestinal tract.

ISOLATION AND CHEMICAL NATURE

McKee, Binkley, MacCorquodale Thayer and Doisy (1939) have isolated two pure compounds with vitamin K activity. Vitamin K₁ obtained from alfalfa is a pale yellow oil which crystallises on cooling and has characteristic absorption bands. The empirical formula is C₃₂H₄₆O₂ or C₃₂H₅₀O₂. Vitamin K₂ isolated from putrefied fish meal is a pale yellow crystalline compound melting at 50.5 to 52°C. Empirical formula is C₄₀H₅₄O₂ or C₄₀H₅₈O₂. From chemical studies of the properties of this vitamin so isolated, it is concluded that the vitamin is a 2-methyl-3-phytyl-1:4-naphthoquinone. The preparation of a pure, stable crystalline derivative, the diacetate of di-hydro-vitamin K, having one half the activity of the vitamin, offers conclusive proof of isolation of vitamin K from alfalfa and putrefied fish meal. 2-methyl-1:4-naphthoquinone though not identical with the naturally occurring vitamin has anti-haemorrhagic properties (Almquist *et al* 1939). This has been confirmed by Macfie *et al* (1939), on human patients.

ESTIMATION OF THE VITAMIN

Estimation of the vitamin deficiency is based on the determination of the prothrombin contents of the blood. There is no direct method of estimation of prothrombin. An indirect idea of the prothrombin content of blood plasma is obtained by the following methods. Almquist *et al* (1937) follow Quick's (1935) method of determining the prothrombin time. According to the generally accepted theory of blood

* Read before the Calcutta University Chemical Club.

coagulation, prothrombin of blood plasma is activated by an enzyme, thrombokinase, obtained from tissue extract, in the presence of calcium to form thrombin; thrombin then converts the soluble fibrinogen, a blood protein, to insoluble fibrin or clot. In Quick's method, oxalated blood is taken and centrifuged. To the oxalated plasma in a tube, known amounts of calcium chloride and thrombokinase prepared from human brain are added. The tube is immersed in a water bath at 37°C and shaken vigorously for a few moments until the mixture coagulates. The time in seconds from the moment of adding the calcium to the moment of coagulation constitutes the prothrombin time. By comparing this with the clotting time of a normal plasma, the prothrombin index is obtained. In normal humans prothrombin time varies between 25 and 35 seconds. In vitamin K deficiency the time usually exceeds 75 or even 100 seconds.

Macfie *et al* (1939) have determined the crude clotting time and have compared this with the prothrombin time determined by Quick's method. According to their view crude clotting time determination is as significant as the prothrombin time. Glass capillaries of diameter 2 to 3 mm. are filled with blood and placed over a dish which is kept at 37-39°C. Portions of capillaries are broken off from time to time and examined. As soon as a clot is formed, easily observed by breaking the capillary and pulling the two pieces apart, the time is noted as the crude clotting time of the sample. By comparing this with the crude clotting time of a normal individual, prothrombin deficiency may be ascertained.

Dam *et al* (1938) follow a different technique in the determination of K-avitaminosis. This method is a modification of that developed by Fischer in 1930. 2 c.c. of venous blood are taken through a cannula and placed in a centrifuge tube containing 0.1 ml. of 0.15% solution of heparin. After mixing and centrifuging, the clotting power is determined by using an extract of human brain. The concentration K of the brain extract which just coagulates the plasma in three minutes, when one drop of the extract is added to four drops of plasma, is determined. A corresponding determination is made on normal plasma (K_n). The quotient $R (K/K_n)$ is a measure of the alteration of the coagulation, while the reciprocal value $1/R$ is a measure of the ability to coagulate with tissue extract. In normal plasma $R=1$. In some new born children R values come to about 300, i.e. the prothrombin content is only 0.3 per cent of the normal.

Vitamin K in food-stuffs is usually assayed on chicks because they become K-avitaminous earlier than other animals, e.g., rabbit, rat, etc. This is supposed to be due to the fact that the large intestine, where putrefaction usually takes place, is comparatively smaller in chicks than in the mammals. It has been observed by Almquist *et al* that vitamin K is present in faecal matter of chicks receiving none of the vitamin in the diet. Possibly the vitamin is synthesised in the lower intestine by putrefactive bacteria present. Newly hatched chicks are given a synthetic vitamin K-free diet for a period of 15 days. Substances to be tested are mixed with the diet. Prothrombin time or R values are determined as usual and by comparison with normal values, simultaneously obtained from normal animals, vitamin K content is ascertained.

A chemical method of estimation of vitamin K in concentrates has been described by Almquist *et al* (1939). The test substance is dissolved in methanol and sodium methylate is added. The mixture is shaken with light petroleum. Interfering carotenoid pigments remain in the petroleum and the colour due to the reaction of the vitamin and the sodium methylate remains in the methanol. A good agreement exists between chemical and biological assay.

VITAMIN K AND DISEASE

Sir James Mackenzie in his treatise "*The Beloved Physician*" has said—"There are three stages in the history of every medical discovery. When it is first announced people say that it is not true. Then a little later when its truth has been borne in on them so that it can be no longer denied, they say it is not important. After that if its importance becomes sufficiently obvious they say any how it is not new."

Conservative surgeons may say that the vitamin K is not important. With modern surgeons, however, this vitamin has been proved to be a very valuable weapon in combating pre- and post-operative haemorrhages in patients suffering from obstructive jaundice.

In all forms of obstructive jaundice due to lack of bile in the small intestine fat absorption is impaired and the fat-soluble vitamin K is not absorbed properly. This leads to diminished prothrombin content of the blood and a consequent haemorrhagic tendency is observed in obstructive jaundice. If

vitamin K concentrates are administered per mouth with bile salts or desoxycholic acid or the vitamin is injected, normal prothrombin time and R values are obtained within a very short time (Illingworth, 1939). Macfie *et al* (*loc. cit.*) have successfully treated several cases of obstructive jaundice with a vitamin K analogue, 2-methyl-1:4 naphthoquinone previously mentioned. This compound has recently been put into the market by Messrs. Glaxo Laboratories as Kapilon. After injections of 15 mg. of the substance remarkable results are obtained.

In new-born, slight haemorrhagic diathesis is usually seen. Blood examination reveals hypoprothrombinaemia. This lack of vitamin K usually disappears within a week. This is due to insufficient supply of vitamin K from intestine. Sick infants are improved by vitamin K administration. (Dam *et al* (1939).

Cases of anaemia neonatorum, icterus gravis neonatorum and hydrops congenitus have got one common symptom in lowered prothrombin in the blood. Most of these cases are improved by vitamin K. Non-tropical sprue is associated with prolonged clotting time. The case is improved after vitamin K administration. Kirk *et al* (1939) have

observed that a dietary deficiency of vitamin K exists in men who are not jaundiced but have prolonged bleeding time. Vitamin K increases the prothrombin content of the blood of these individuals. Vitamin K therefore seems to be very valuable agent in combating haemorrhagic diseases due to lack of prothrombin in plasma, for which there was so long no other remedy.

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PLANT ROOTS CONSERVE SOIL

IN order to determine the relative efficiency of various cultivated crops in prevention of soil erosion, Dr Howard J. Dittmer, of Chicago, has investigated the root systems of several plants. The results will be surprising to those who are not familiar with the aggressive fight plants make for life.

It was found that the average number of roots in each cubic inch of soil in the top six inches ranged from 80 for soybeans to 2,000 for Kentucky blue grass. The total length of the root hairs of soybeans in a cubic inch averaged 40 feet, and in the case of blue grass more than 4,000 feet. The total surface area of the root hairs in cubic inch averaged only 3.5 square inches, while in the case of blue grass it averaged over 200 square inches. These figures are a measure of the contact of these plants with the sub-surface world as well as of their power of preventing soil erosion.

Dust Magnet and Bactericidal Gun

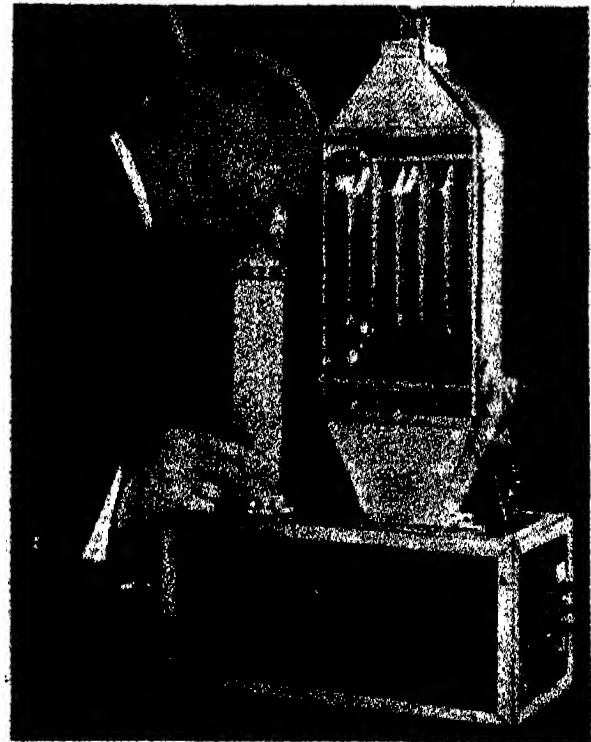
ANDRE' LION

AIR-BORNE dust and bacteria are present everywhere, but more disastrously so in the air above cities. Investigation has shown that the average resident of an industrial city inhales at least a teaspoonful of dirt each day. Ninety per cent of all impurities in the air we breathe are smaller than one micron, that is smaller than $1/25,000$ th of an inch, much below visibility of the naked eye. Over a smoky industrial city, a cubic foot of air contains up to from 200,000 to over 4,000,000 dust particles and microbes. We see the tiny motes dancing in a ray of sunshine but our eye cannot detect the vast majority of the impurities in the air: pollens which cause hay fever and asthma, from 15 to 25 microns in size; bacteria, averaging 1 to 2 microns in diameter; smoke particles of 0.3 or tobacco smoke corpuscles of 0.1 microns. Are these particles harmful? Of course, they are. Bacteria spread typhoid, pneumonia, influenza, colds, tetanus, tuberculosis, etc.; mould spores grow on bread, meat, and milk; smoke and dust collect on our walls and furniture; grime ruins merchandise on display; and all that is but a small excerpt of an extensive record.

To purify the air by passing it through screens and filters, which today is accomplished in many thousands of air-conditioning units in homes and offices or exhaust systems in dust-producing plants, is a rather inadequate job. Even the finest screens remove only a small portion of the finer air impurities. Their tiny mesh leaves the door wide open to bacilli which never measure more than $1/100$ th of the diameter of a human hair and mostly much less. There is another rather ingenious way of removing diminutive impurities from the air, and that is the electrostatic precipitation. The particles are not filtered out but electrically charged and pulled out of the air by an electrical force; just as a magnet attracts iron filings. The possibility of cleansing gases by an electrical discharge was discovered 115 years ago, but only by the Precipitron, invented in the Westinghouse research laboratories, has this ideal method of air cleaning been so simplified, compacted and practically developed that it now can be used economically for air purifying in homes, stores,

offices, restaurants, hotels, and industrial plants. Now tobacco smoke particles measuring about $1/2,000$ th of the diameter of a human hair may as readily be removed from air as larger impurities such as soot or pollens.

The Precipitron, this novel dust magnet, consists of a number of units, individually installed and assembled, depending on the special job, the volume of air to be handled, and the space available. There are two standard sizes of units, shaped like flat boxes, the smaller cell being rated at 300 to 375 cubic feet of air to be cleaned per minute, the larger one at



MODEL OF A PRECIPITRON UNIT IN WHICH, BY ELECTRO-STATIC PRECIPITATION, EVEN THE FINEST DUST PARTICLES MAY BE REMOVED FROM THE AIR. IN THIS PICTURE, TOBACCO SMOKE, THE PARTICLES OF WHICH MEASURE ABOUT $1/2,000$ TH OF THE DIAMETER OF A HUMAN HAIR, IS BLOWN INTO THE CYLINDER AT LEFT. WHEN PASSING THROUGH THE PRECIPITRON CELL AT RIGHT, THE AIR INSTANTLY BECOMES PURIFIED AND CLEAR.

600 to 750 cubic feet, resulting in an air purification of 85 to 90 per cent.

In order to remove a dirt particle from the air electrostatically, it must be given an electrical charge and then placed in an electrostatic field with a voltage gradient high enough to attract it out of the air on to a plate where it will stick by its own adhesion. Thus each Precipitron cell consists of two parts, the ionizing and the precipitating units.

In the ionizing chambers the air passes small wires placed between grounded cylinders. The wires are supplied with high voltage electricity, thus ionizing the air between the wires and the neighbouring cylinders and creating a kind of electrostatic screen passing through which all dust particles are electrically charged. Next, in the precipitating chambers, the air passes a number of closely-spaced parallel plates. Alternate plates are grounded and electrically charged, thus setting up another electrostatic screen between the plate systems. As the air passes through the parallel plates, this screen exerts a force on its charged dust particles, pulling them to the grounded plates where they are deposited, allowing almost completely purified air to be discharged through the outlets. A small power unit supplies direct current of 12,000 volts for the ionizing and of 5,500 volts for the plate section of the Precipitron cell from any electric supply line.

There are many spheres of application of the Precipitron. Industrial dusts which constitute a hazard to the health of employees or interfere with production processes may be removed. Frequently, this dust is valuable and justifies collection. For example, a West Virginia pottery has installed ten Precipitrons on its automatic glaze-spraying machines to recover excess glaze in suspension from the exhaust air. Each of these precipitators in a 40-hour week collects 800 lbs. of glaze, valued at from \$48 to 1600. Air may be cleaned to protect delicate apparatus such as automatic telephone switching equipment to which considerable trouble may be caused by dust so fine that it cannot be removed by other than electrostatic means. In a private telephone exchange the average monthly number of service interruptions due to dirt thus has been reduced from 22 to only 9. The air may be cleaned in stores to reduce damage to merchandise or in homes and offices to diminish cleaning costs of walls, draperies, furniture, and files. By this modern means, the first four floors and lower arcade of the new Field Building, tallest in Chicago, are supplied with over 16,000,000 cubic

feet of dust and germ-free air every hour. Finally, electrostatic air cleaning may result in a real relief to hay fever and asthma sufferers and may, moreover, reduce the bacteria content of the atmosphere in operating rooms and hospital wards, thus lowering the rate of deaths and contagion following operations. The American Society of Heating and Ventilating Engineers, in co-operation with the Department of Industrial Hygiene of the University of Pittsburgh has just begun a programme of investigation on how the bacteria content of the air, especially in operating rooms may be affected by precipitation and ultra-violet sterilization of dust. The clashing together of dust precipitation and ultra-violet sterilization in prominent research plans leads to the other modern means of air purifying. Of course, ultra-violet radiation does not free the air of its mineral or smoke constituents, like silica dust or tobacco smoke. It only attacks and kills living matter, such as bacteria, germs, spores, and mould.

Ordinary sunlight has sterilizing power but its action on bacteria is relatively feeble after penetration of the atmosphere. Even the employment of only the ultra-violet spectrum without its neighbouring visible wavelengths is a senseless and costly means of killing micro-organisms, no better than killing rabbits with an elephant gun. For only a very limited range of the ultra-violet spectrum, that is the radiation of exactly 2,537 Angstrom of about 1/100,000th of an inch wavelength, is an effective microbe death-ray, though harmless to humans. In the same Westinghouse research laboratories in which the Precipitron has been achieved, the Sterilamp has been developed, a rod shaped gas-discharge lamp containing mercury vapour and other emitting gases. The discharge of electricity passing through this tube brings about an almost heatless emission of selected ultra-violet radiation which contains about 80 per cent. of 2,537 Angstrom emission. Thus the elephant gun has become a very efficient bactericidal gun, and a very cheap one at that, requiring no more electrical energy than a 10-watt lamp and possessing a useful life of approximately 4,000 hours.

No wonder that this gun, shooting all around, is most effective against post-operation infections in operating rooms. The aseptic technique used by modern surgeons has provided no defence against contamination from the air. Tests in a North Carolina hospital have shown that colonies of the dangerous staphylococcus bacillus were rendered

sterile after only one minute's exposure to the radiation of a Sterilamp at a distance of five feet. Operations on patients have been performed under the lamp, and from the first the results were striking. Virtually all the bacteria in the air about the operative wound, the supply and instrument tables were killed and even in the extreme corners of the room the radiation eliminated eighty to ninety per cent of the germs. Without exception, where Sterilamps have been installed in operating rooms—and this has been done in numerous United States hospitals—infections, formerly a constant hazard, have practically disappeared.

The great advantage of this bacteria gun is that it may attack and annihilate any germ not shaded from its invisible rays, whether still floating in the air or already deposited on their prospective prey. That is why this lamp is ideal for use in electric refrigerators in which a steady flow of air takes place on account of the cooling process. A recently developed small Sterilamp is now available as a plug-in accessory to refrigerators. Not only any kind of mould on bread or milk is killed but also any bacteria floating in the circulating air before settling on meat or fruits.

Wherever sterile air and surfaces are requisite to the preservation of health, these special ultra-violet lamps are expedient and now used in a thousand places. Grocery, meat, dairy, and bakery stores have tried these lamps out and obtained substantial savings in terms of less spoilage, longer life, and higher quality of their merchandise. Two large firms of the baking industry have been using the lamps to retard mould growth on fruit cakes, and consequently, spoilage fell from fifteen per cent to a trifling one or two per cent. In many other instances the lamps prevent mould contamination of baked goods in cooling rooms and during the wrapping process. On farms, barns and bows may be scrubbed, milking pails and operators' hands may

be washed, but heretofore no satisfactory method has been known of preventing air-borne germs of falling into the pail before raw milk is bottled. Today, Sterilamps are being used regularly in a number of farms, not only in connection with the milking operation, but in hen-houses, brooder-houses, and hog-pens. One of the largest poultry farms in the United States has these lamps installed to combat chicken infection. In restaurants and soda fountains, where common methods of cleaning drinking glasses, dishes, and silverware are ineffective in destroying all bacteria and often constitute a menace to public health, Sterilamps have proved to be complete sterilizers of these easily contaminated utensils and to keep them sterile up to the moment of use. They are the ideal solution for this problem, since they can be installed in series along the inside shelves of bars and soda fountains, in wire glass-holders, etc. They accomplish a sterilization of 99'99 per cent in a few seconds' time, thus effectively controlling the spread of air-borne diseases, such as colds, grip, pneumonia, and many others.

For the same reason a New York bank has a Sterilamp installed over each teller's window, to reduce the hazard of communicating cold germs and other disease-breeders. One of the best known cosmetic factories in the United States is using these lamps to irradiate toothpaste and cleansing creams. Several manufacturers of food products even installed Sterilamps in the air ducts of their ventilating and conditioning systems, and tests indicated that an exposure of a little more than one second killed ninety per cent of the bacteria floating in the air.

Thus today, two modern means, electrostatic precipitation and ultra-violet radiation of a selected wavelength, are used to make the air which we breathe and which comes in contact with the necessities of life as pure as that of the highest mountain peaks where the sun itself does that work without need of human help.

Wheat and Couch Grass Hybrids

N. V. TSITSIN

[We publish below an account of hybridisation of wheat and couch grass done at U.S.S.R. The species of couch grass of the genus *Agropyron* are found mostly in the temperate region. In India *Agropyron* is met with only in the Himalayas and at a fairly high altitude (5000—14000 ft. usually). *A. repens*, which is one of the 5 species used for the above experiment, is found in the Himalayas at elevations of 8000—14000 ft. The paper has therefore not much bearing on the improvement of wheat or other crops in India. But whether the hybrids obtained from *A. repens* or from other species will be suitable for the plains of India may be a subject for investigation of Indian workers on this line. The problem tackled in this paper may therefore attract attention of Indian plant geneticists towards undertaking experiments on hybridising wheat with the Himalayan species—*A. repens* or other allied species of Indian grasses.

—Editor.]

AS a result of extensive research the following species of couch grass: *A. glaucum*, *A. elongatum*, *A. irichoporum*, *A. junceum* and one variety of creeping couch grass, *A. repens* have been crossed with wheat. Experiments have shown that different varieties of the above species of couch grass can be crossed with all species and varieties of wheat. This enabled us, research workers, to formulate a number of definite tasks in this work. We undertook to develop hybrids with the following properties: (i) A highly productive variety of cereal with a large yield of grain of high nutritive value, (ii) Frost-resisting varieties capable of withstanding severe winters with but little protection from snow, and (iii) Drought-resisting varieties suitable for cultivation in the drought-subject areas of the Soviet Union. In 1930 after successfully evolving wheat and couch grass hybrids, a hypothesis was advanced on the feasibility of developing a new variety of plant unknown in nature, namely, perennial wheat and in 1934 this hypothesis was proved in practice.

It will be interesting to draw here a comparison between wheat and couch grass. Wheat is a plant cultivated by man, and consequently the various qualities and properties, it possesses, were gradually forced by man who adjusted this plant to his requirements. But couch grass, on the contrary, had to fight for its existence, accumulating all its properties and qualities, adjusting its organism to all sorts of exigencies and unfavourable conditions of growth. Thus, historically the development of wheat and couch grass was totally different.

Wheat as compared with couch grass is a much more tender and capricious plant which man protects by various cultivation methods from dry winds,

cold, frosts and so on. On the other hand, man is trying to exterminate couch grass by such methods as drying and freezing its rhizome, though these efforts are not always successful. Wheat requires good soil and grows poorly on inferior land. Couch grass, however, is so unpretentious that some of its varieties can even grow in salt marshes and soil containing salt. Most of the wheat varieties are subject to fungal diseases, such as rust on stalks and leaves, smut, bunt and mildew, while many varieties of couch grass, as a rule, are not affected by these diseases. Couch grass, however, grows on marshy lands next to sedge, on salty lands and salty marshes, in sands and rocky mountain slopes, in arid plains and under the shade of trees and shrubs, and it can be found everywhere. In the process of struggle for existence couch grass has become very hardy. It can resist both high and low temperatures. The tremendous capacity for self-propagation which is accomplished both by vegetative propagation and true reproduction renders the struggle with this plant extremely difficult. A powerful rhizome which accumulates a great reserve of nutritive matter makes couch grass one of the most unpretentious plants.

Our experiments have disproved the conception current formerly that couch grass, in view of its adaptability to reproduction by vegetative propagation, is a plant of little fruitfulness. The great fruitfulness of certain varieties of couch grass (5,000 seeds and more in one plant as compared with 100 and 150 in wheat under the same conditions of growth) makes it extremely valuable for hybridisation. Taking account of all these valuable properties experiments were undertaken to transmit them by heritance to cultivated plants and we began experimenting

on the crossing of wheat with couch grass. The first generation born of a crossing of the seeds of wheat and couch grass resembles couch grass in outward appearance. Its shoots just like the shoots of couch grass are of violet, reddish or orange colour. The plant has many stalks. Outwardly the ears resemble those of couch grass and only a close examination would reveal a number of properties inherent in wheat.

All plants of the first generation are perennial. It should be noted that the hybrids react sharply to an improvement in conditions of growth. Proper cultivation and mineral fertilizers raise the yield from one and a half to two times. The plants have powerful roots which at times extend for two metres, a fact of tremendous importance in developing drought and frost-resisting varieties. In their resistance to drought and cold hybrids of the first generation considerably exceed even couch grass. In the main, plants of the first generation are totally immune to rust and smut, the usual diseases of wheat. The hybrids could be divided into two groups—the spring and winter varieties; it is highly significant that hybrids obtained by crossing couch grass with spring wheat produce grain at the first year while hybrids obtained from crossing winter wheat bear grain only at the second year. As an exception there are some plants which behave differently from other plants in the group.

Hybrids of the second and third generation received by continuous crossing with wheat pollen bear mostly the properties of an intermediary variety: the original properties of the hybrid undergo a change; the property of a perennial plant grows weaker with each succeeding generation; on the other hand, the fruitfulness rises and most plants retain the resistance to diseases possessed by couch grass. At present we have a number of varieties of annual and perennial wheat which possess valuable properties. Of great interest among the perennial wheats are two varieties known as 34085 and 23086. A specific quality which distinguishes the perennial varieties from the usual annual wheat is their ability to grow again after harvesting and to come to life after wintering. The perennial hybrids of wheat, variety 34085, represent powerful plants with many stalks and strong leaves. The roots are fibrous in the main. In the presence of moisture they are capable of forming creeping roots. The stalks are straight. The plants have an average height of 65 to 70 centimetres. The straw is rather strong and does not tend to lodge.

A number of plants of this variety has the property of producing in field conditions roots above the surface, the formation of the latter usually takes place at height of 2 to 3 centimetres from the ground. The number of stalks that head into grain from these roots reaches 6 to 7. The ear when the grain ripens is of white colour with a yellow tinge; it is hard to thresh and is bearded. The ears grow to an average length of 6 to 10 centimetres. An ear has 16 to 18 spikelets, the spikelet has from 6 to 7 flowers, while the number of kernels varies from 3 to 4 and sometimes 5 and 6. The number of grains in one plant reaches on the average 300 to 350. The seeds are red and large and weigh 25 to 33 grams per thousand.

The above variety of wheat possesses great vitality. Research has shown that in three years under experimental conditions it is capable of yielding 7 to 8 crops without replanting. Experiments in field conditions are now in progress. Even under the unfavourable conditions of last year, perennial wheat 34085 yielded 25 metric centals per hectare exceeding the yield by 7 metric centals of the best varieties of wheat. The particular resistance of variety 34085 to drought and salt makes feasible its tests on salty soils and in districts of a sharply continental climate.

The other variety 23086 also possesses very valuable properties. As distinct from 34085, it is beardless and possesses great resistance to cold. At present we also have developed a number of other varieties of perennial wheat which are of considerable interest. Our experiments offer grounds for the assumption that perennial wheat when planted in the northern and central regions of the Soviet Union would yield one harvest of grain and would also be mowed once a year for fodder. In the southern regions it would be feasible to raise two harvests of grain and one fodder crop a year.

The hybridisation of wheat is remarkable for the fact that it solves in principle the problem of the possibility of developing perennial wheat, which until very recently was a debatable question in agricultural science. Alongside with the numerous varieties of perennial wheat we have also developed annual plants. The annual hybrids of wheat and couch grass in the main are not inferior in their yields to wheat. A number of varieties produces a yield considerably higher than wheat as well as a superior grain.

There are hybrids producing yields 50 per cent higher than the best varieties of wheat such as Lyutetsens O 62 and Tsezium O 111. Some varieties of hybrids though infected with spores of smut for a number of years have proved immune to these. Similarly there are varieties absolutely immune to rust on stalks and leaves. The variety 22850 in natural conditions even with the excess of moisture does not lodge. This variety is not affected by smut, bunt or rust and neither does it shell out. Its baking qualities are even superior to those of the best standard wheat Tsezium O 111. In 1938 it yielded 34.5 metric centals per hectare

as compared with 13.2 metric centals of Tsezium O 111.

Experiments are at hand on crossing other cultivated plants with the wild growing flora. For example, the rye-couch grass hybrids we have developed, enabled us to solve the problem of evolving a new variety of rye with changes in the biochemical properties of the grain. The hypothesis advanced by us several years ago that for every cultivated plant it is possible to find a wild growing one for crossing has now become the guiding principle in the work of many Soviet scientists and experimenters.

BACTERICIDES FROM SOIL

DR RENE' J. DUBOS working at the Rockefeller Institute for Medical Research in New York has discovered a new method of producing bactericidal agents. Dr Dubos began his line of research nearly a decade ago. He mixed a large number of soil samples gathered from different localities, baked the mixture at moderate temperature to decompose most of the dead organic material, and then injected a sample of the specific bacteria for which he sought a killer. One of his early trails was with the Type III pneumococcus, cause of one of the most baffling and destructive types of pneumonia. After an appropriate waiting period, he analyzed the soil to find a bacillus whose enzyme dissolved the shell of the pneumococcus. Later instead of a single bacterium, he inserted in his soil sample a potpourri, including pneumococci, streptococci, staphylococci—all representatives of the Gram-positive group of bacteria, named after the Danish scientist Hans Christian Joachim Gram, who indicated a significant division among bacteria on the basis of their ability, or lack of ability, to retain a certain violet dye. Analyzing his soil sample at the end of two years—during which time he had added more Gram-positive bacteria periodically—Dr Dubos found a bacterium that was less selective in its bactericidal tendencies. He described it as a "Gram-positive, spore-bearing, aerobic bacillus, capable of lysing the living cells of many Gram-positive microbial species". In fact all Gram-positive species thus far tested are killed, many of them dissolved, by the exudates of this one bacillus.

The *Technology Review* reports that further study revealed that a fractionation of the agent released by the bacillus and soluble in alcohol, acetone, and dioxane, but not in water, was the true bactericidal agent, and that it was fifty to one hundred times as active as the original extract. When tried on mice, a single milligram was sufficient to ward off as many pneumococci as would normally kill ten thousand of those animals. On the basis of such tests, it appears that a bacterium lacking the type of food to which the strain has been accustomed, may adapt itself, developing an enzyme that will digest whatever organic material happens to be present. Once the bacillus was isolated, it was cultured in peptone until large amounts of its bactericidal enzyme could be extracted with the centrifuge. The agent is yet to be tried on man.

Dr Dubos hopes to find in nature microbial species with catalysts for any type of biochemical reaction. He further hopes that some day soil organisms opposite in character to the present ones will be discovered, such as Gram-negative bacilli and the acid-fast bacteria, causing tuberculosis and leprosy.

Food and Nutrition

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INTRODUCTION

MAN must have food in order to provide for materials for the growth and development of the physique as also to have adequate supply of energy for his bodily requirements. The amount and the quality of food vary according to various factors such as age, sex, occupation, etc. As a result of physical exercise and the various vital processes within the body including thinking there is wear and tear of the body tissues which require to be constantly replaced. Even when a man is normally asleep, the vital parts of his organism are working continuously and food has to be provided for such processes to continue their function in a healthy manner.

For the purposes mentioned above the various kinds of tissues forming the human body, that is, nerves, muscles, bones, glands and other cellular organs have to be provided with suitable special types of food elements. For muscles and bones, protein and certain minerals like phosphorus, calcium, etc., are essential. Similarly, for the nervous tissues, protein, phosphorus, carbohydrates are essential. To keep the metabolism in the human body in proper order, one must have adequate supply of different types of vitamins. Vitamin A is necessary for giving man the power of resistance to infectious diseases. It assists growth and prevents night-blindness. It is found in butter, eggs, ghee, oil, meat, milk, liver—particularly of fish—and green leafy vegetables. Vitamins B₁ and B₂ are found in the pericarp of cereals like rice, wheat, maize, etc. Vitamin C is found in all citrous fruits like lemons, oranges and limes and in fresh vegetables and meat, which, however is largely lost in cooking. Vitamin D is found in eggs, milk, fat, liver—particularly of fish. The human skin also produces this vitamin when exposed to sun's rays. Vitamin E is found

in the germinated portion of all cereals, seeds, eggs, etc. These vitamins should be present in adequate quantities. This is essential because not only do they have specific actions themselves on the body but many of them have also marked influence over the action of the other. In other words, they assist mutually to a great extent. For production of energy, fats like ghee, butter, oil and carbohydrates like wheat, rice, sugar and vegetables are essential. For the total requirement of the body, there should be proper supply in different forms of the following essential principles of food: proteins, fats, carbohydrates, salts, vitamins and water. These are found in different quantities in different articles of food. Protein is found in meat, fish, lentils, milk, eggs, etc. Carbohydrate is found in rice, wheat, milk, certain tubers, vegetables like marrow, fruits, etc. Fat is found in milk, butter, ghee, mustard and other edible oils like *til* and cocoanut.

In the problem of supplying wholesome food and the necessary nutrition the following factors are involved: (i) production and supply, (ii) preparation, (iii) cooking, (iv) distribution and sale, (v) quantity and quality, (vi) ingestion, (vii) utensils, (viii) assimilation and excretion, (ix) age and sex, (x) occupation, (xi) climate, (xii) cost, and (xiii) adulteration of food.

PRODUCTION AND SUPPLY OF FOOD MATERIAL

As food is essential for life, it is desirable that the country should produce its own required food supply. When a country cannot produce the required amount, the deficiency can be met by supplies from other countries. This is possible now due to easy communications all over the world. In order to do so, the country must have the wherewithal to pay for the commodity imported. Usually those countries which do not produce sufficient food, pay for the imported food material by exporting industrial or other products. For example, England exports large quantities of industrial products in order to pay for

* Based on a lecture delivered at the Calcutta Corporation Commercial Museum on the occasion of the Food and Nutrition Exposition.

her food material. It is needless to point out that our countrymen are undernourished. Food is not in abundance and added to this, the poor cultivators are compelled to sell off a part of their own food-crops to meet other demands. On the other hand, industries are yet to grow to supply to our needs, not to speak of exporting their products. There should therefore be a concerted drive to produce our own food materials in sufficient quantity at present. Efforts may be made for more intensive production by adopting suitable methods, and if necessary, with the help of State protection. Only a decade or so ago India used to import a huge quantity of sugar, but now mainly by a revision of the trade policy, particularly with regard to this commodity, sugar industry has become self-sufficient. India still imports large quantities of rice. One of the main reasons for this deficiency is the low yield per acre on account of poor quality of the soil. Japan produces nearly 15 to 16 maunds of rice per bigha whereas we produce on an average only 7 maunds. Although mustard oil and ghee are consumed to a great extent in Bengal, the province barely produces half of her requirements.

PREPARATION OF FOOD

After the food supply is obtained, it has to be properly prepared. For example, paddy has to be husked and the rice from it has to be cleaned and washed. Home-pounded rice is far superior in food value to milled rice. Yet it is a matter of great regret that sufficient quantities of home-pounded rice are not available for even the Government or Government-aided institutions. Similarly, vegetables have to be cleaned and the meat dressed. Such preparation should be done in a clean place and in a scientific manner. Rice should be cleaned but not rubbed hard during the process of washing, as by doing so a lot of salts and vitamins are lost. Similarly some vegetables and fruits should be eaten with their skin on, for example, tomato, apple, etc., while others like mango should be peeled. Those food articles which are eaten raw should be particularly and carefully cleaned and washed with clean water, otherwise there is chance of bowel diseases.

COOKING

From time immemorial cooking has been a great art. King's connoisseurs, as well as the poor, have enjoyed and eulogised a properly cooked meal. In the European countries in the modern hotels, 'chefs',

usually men, are highly-paid persons. In this country, women as a rule have excelled in this art, in any case, in private homes. Cooking is really a scientific art but a great deal remains to be done on a scientific basis. The material should neither be overcooked nor underdone. Only when the food is properly cooked, does proper assimilation take place and one gets the greatest benefit. Certain articles require to be cooked at a low temperature but for a long time, while others require to be cooked at a high temperature but rising gradually. Overcooking makes the food insipid, while food which is underdone may give rise to griping. Overboiled milk loses most of its vitamins, while underdone vegetables are not good for digestion. Cooking of rice in a proper way is essential to get the best benefit out of it. Rice should be cooked in such a way that no water has to be thrown away after it is cooked, as otherwise one loses a great deal of vitamins and valuable salts. Cooking under steam pressure probably gives the best results. Fried food is usually not very beneficial although it may appeal to the taste.

DISTRIBUTION AND SALE

In our social dinners large numbers of people are invited. But do we take the utmost care for the proper cooking and distribution of the food to our guests? Do we ensure that the banana or other leaves or earthen platters on which food is served are scrupulously washed and carefully cleaned first? Very often we do not and that is why we so often notice dirty finger marks on them or sometimes actually find dirt attached to them. Do we ensure that no food which is distributed to the guests is touched by hand? We do not. And that is why it is a common sight to see pilau, fish, curry, dal, sweets being distributed by hand without a spoon or ladle being used. Nor do we ever bother even to make enquiries about the people, cooks, servants, etc., whom we engage for such occasions as to whether they have suffered from any communicable diseases such as dysentery, typhoid, cholera, tuberculosis and syphilis. It is because of this utter carelessness and indifference to rules of health that we find tragedies happening in homes after a person or persons have been to a social dinner. Typhoid and para-typhoid, cholera, acute diarrhoea, indigestion, etc., are some of the penalties we have to pay if we accept a large-scale social dinner. Meat and fish are very often sold under very unsatisfactory conditions.

Cooked food is often sold under very unhygienic conditions. The conditions prevailing in a very large number of tea-shops and lower-grade restaurants are simply abominable. There is no proper arrangement for washing the used plates, cups and saucers. These should be effectively controlled by the local authorities who are primarily responsible for issuing licenses to these places. The terms under which the licenses can be granted should be carefully framed and clearly stated at the back of the license. The remedy requires a little planning and the will to do the best for the community.

QUANTITY AND QUALITY OF FOOD

In order to get full nourishment one has to eat a sufficient quantity of food. Not only quantity is necessary but the quality is also essential. There is a good deal of difference between fresh food and food which is either stale, contaminated or of poor quality. Rice is usually decried as an article of diet because of its alleged poorer nourishing value than wheat. But the defect lies in the faulty method of preparation and cooking, when rice loses most of its vitamins, nitrogen and salts.

INGESTION OF FOOD

This is an important process. One must not consider that one can gulp down food and derive the best benefit out of it. That is not so. The food should be properly masticated so that the saliva gets an opportunity to mix with the material. It is only then that proper digestion and assimilation could occur lower down in the stomach and in the intestine. Further, food should be taken in a clean place kept apart for the purpose and, wherever possible, in good company. A cheerful mental condition at the time of ingestion has an important effect on the digestion and assimilation of food.

UTENSILS

It is needless to assert that utensils from which food is taken should be scrupulously clean and should be of such material as is not affected by the food itself either during its cooking or when it is being eaten. For example, badly timed utensils when utilised for cooking may give rise to copper poisoning, while acid material put on brass plates may give rise to metallic poisoning. Similarly dirty plates, cups and glasses may give rise to communicable diseases, such as typhoid and cholera.

ASSIMILATION AND EXCRETION

No matter how food is prepared, no matter how much it may be of good quality, if one is not able to assimilate it and derive the best benefit out of it, ingestion of food only leads to excretion of large amount of faeces. In order that assimilation may take place to the highest extent, one must be physically fit; bowels must move properly and he must take sufficient exercise. Physical exercise is particularly important for rice eaters, that is the only way in which real benefit can be derived from rice. This is clearly shown by the Nepalese and the Japanese who do not shun manual labour. On the other hand, the Bengalees and the Madrasees suffer from a shyness of physical labour—particularly the Bengalees, with the result that they suffer very greatly from diabetes and bowel diseases. Bulky vegetable diet increases the amount of faeces, whereas a diet rich in protein does not do so.

AGE AND SEX

Growing children require proportionately much more nourishing food than people advanced in age. After the age of 40, one should cut down the quantity of food that one takes daily and occasionally fast, say, once a month or so. Carried out in a reasonable manner, fasting is beneficial for health, particularly when the life's sun is on the decline. Women, when they are pregnant, require much more nourishing food as they have to supply all the building material not only for their own bodies but for the infant which is growing inside the womb. Serious deficiencies in the elements of food during the period of the gestation may have a very regrettable influence over the growth of the child. The bones may be soft and the child may be deformed. Similarly people doing hard manual labour require a different type of food from those doing brain work. The former require proportionately more carbohydrates such as are contained in rice, wheat, etc., and in fats and oils, while the latter require comparatively more of proteins such as are obtainable from meat, fish, *chhana*, cheese, dal, etc. Therefore we must exercise intelligent discretion regarding the articles of food and drink that we require in accordance with the factors mentioned above.

OCCUPATION

A man doing hard physical labour, such as a blacksmith, requires a comparatively large quantity of food and can digest properly a greater proportion

of carbohydrates, such as rice and wheat, while a brain worker or a man with a sedentary habit requires more of protein and less of carbohydrates. If a maximum amount of energy is required to be produced in a minimum space of time, a greater proportion of protein is required, while the man with the predominantly carbohydrate diet can suffer privation longer.

CLIMATE

Our food must be suitable to the time of the year, that is, to a certain extent there should be a variation during the winter and summer. The essential element must remain the same but more fat may be consumed in order to help the body in the production of more heat during winter. Conversely, during summer, there may be a certain reduction in the consumption of fat and meat.

COST OF FOOD

In a comparatively poor country like India, the cost of diet is a very important item in the family budget. As the wage earning capacity of an individual is practically the poorest in the whole world, he cannot have very much to spend on his family budget as a whole. In European countries, cost of food generally forms 25 to 33 per cent of the income of the average middle class and in the poorer classes about 40 per cent. But, in India, food practically forms nearly 60 per cent and at times even more than that for the poorer classes. This means ultimately that in India there is very little reserve left to fall back upon when the earning capacity is reduced or when the wage earner is unemployed. However, one has to make the best out of the present circumstances and one must cut down the superfluous food material from which one cannot derive the fullest possible benefit. Even with the limited resources available at our disposal it is possible to do so. Many articles which we consume in large bulk can be safely reduced in quantity and replaced by more nutritious material required in much lesser quantity, which would not entail any extra expenditure. The Public Health Department of Bengal has worked out a number of cheap menus varying in cost, the minimum of which is Rs. 3/- per head per month and some of these have been mentioned in the booklet written by the present writer "*Problem of Rural Reconstruction*." But we must not run away with the idea that the minimum is the optimum. For an average middle class Indian family, Rs. 12/- per head per month may be suffi-

cient. We should spend a sufficient amount on food commensurate with our income, but at the same time we must get the fullest benefit from the diet for the nutrition of our body, as it is only by doing so that we can maintain our health and physical fitness to produce the maximum amount of wealth which the community demands of every citizen living within its ambit.

ADULTERATION OF FOOD

It is a matter of regret that when money is found, proper nutrition cannot be ensured due to adulteration of foodstuffs by unscrupulous persons. Unless articles are purchased from reliable vendors, we are likely to be cheated by dishonest dealers. Adulterated mustard oil gives rise to epidemic dropsy and adulterated flour may give rise to severe choleraic symptoms. One of the best methods to tackle this, from the point of view of the community, is not only the enforcement of the Food Act dealing with adulteration or safeguarding the standard of purity of food, but organised boycott of those unscrupulous grocers and shopkeepers who deal in them. The enforcement of such Acts largely depends upon the local authorities and for this purpose they must maintain an adequate staff of properly qualified men. There must be laboratory facilities for the examination of the sample of food. Development of local facilities should be encouraged where desirable but the question of undue parochial influence has to be borne in mind. The alarming state of affairs regarding adulteration is shown below.

PERCENTAGE OF ADULTERATION.

Food articles	District Boards.		Municipalities.	
	Percentage found adulterated.		Percentage found adulterated.	
	1937.	1933.	1937.	1933.
Mustard oil	21.0	32.0	21.3	28.1
Ghee	41.7	23.1	31.9	27.7
Milk	68.4	77.1	72.7	71.6
Atta and				
Wheat flour	8.7	nil	3.7	1.9
Tea	5.7	nil	10.5	nil
Channa	23.3	15.7	nil	nil
Dahl	85.4	85.7	59.0	77.7
Butter	...	...	27.2	83.3

NUTRITIONAL FACTOR OF FOOD

Not only should one have sufficient food but one must have a balanced diet. Unless this is achieved, any one or more of the diseases mentioned below may arise:

Diarrhoea, Dyspepsia, Constipation, Diabetes, Beri-Beri, Sterility, Amblyopia, Rickets, Osteomalacia, Scurvy, Pellagra, Lathyrism and Carious teeth. Food which is very rich and contains a lot of acid element, contaminated food, food which is not properly cooked and unripe and rotten fruit cause diarrhoea and dyspepsia, while inadequate roughage leaves little residue and leads to constipation. Overconsumption of sweet and starchy food particularly, when combined with lack of sufficient exercise, leads to diabetes. Continued eating of polished rice cause beri-beri. Lack of consumption of eggs, seed grains which are devoid of the germinal parts may lead to sterility. Insufficient consumption of food like butter, leafy green vegetables which contain vitamin A may cause amblyopia. Lack of consumption of sufficient quantity of milk, eggs and other foodstuffs which provide the calcium of the body as well as lack of vitamin D leads to rickets and osteomalacia. Long continued consumption of tinned and dried food, absence of citrous fruits, fresh vegetables, fish, meat, milk in the diet causes scurvy. Similarly long continued deprivation of vitamin B₂ may give rise to pellagra, while continued consumption of *Khesari dal* causes lathyrism.

From the analysis of figures of examination of school children in the province, it seems that defective diet is common both in the rural and urban areas. This rather supports the view that the food in this province is deficient in nourishment and is ill-balanced.

Apart from the diseases mentioned above, ill-balanced and insufficient diet has a definite bearing on the incidence of such diseases as tuberculosis and leprosy which get a much easier hold on people who are ill-fed, especially when the diet is ill-balanced. As a matter of fact, good nutritional level increases the powers of general resistance, particularly to infectious diseases.

CONCLUSION

What is essential with regard to food is that we must have a balanced diet. A balanced diet should contain protein, carbohydrate, fat, vitamins, salts and water in proper quantities. It should not only be qualitatively correct but the quantity should also be sufficient. It is not essential to have meat always. A good deal depends on the availability, climate and habit with regard to vegetarian and non-vegetarian diets. But it has been well established by Sir Robert McCarrison that Sikh diet is practically the best diet in the world. It consists of wheat, vegetables, milk and milk products. Meat is only occasionally taken. At least one third of the total amount of protein required for the body should be of animal origin, which need not necessarily mean meat but may be fish, eggs, or milk products. For a normal person, the food should contain a certain amount of roughage. This helps to keep the bowels open and prevent the serious obnoxious effects of constipation.

PHILANTHROPIC CONTRIBUTIONS IN U.S.A

The record for the year 1939 throws no new light on the question as to whether the total annual amount of philanthropic contributions is likely to rise or fall. On the other hand, it does confirm the impression that the base of supply is steadily widening. It is significant that a Masonic body in Ohio is contributing \$50,000 a year for research in mental hygiene. It is significant also that the human as well as the economic problems of modern housing are being attacked by Federal, State and municipal authorities, by two younger foundations, the Ford and the John B. Pierce, as well as by certain of the older ones, and finally by real estate and insurance interests, notably by the Metropolitan Life Insurance Company, which is investing some \$65,000,000 in a housing development in New York City.

—Report of the President of the Carnegie Corporation of New York.

The Royal Botanic Garden, Calcutta

K. BISWAS

Superintendent, Royal Botanic Garden, Calcutta.

HISTORY OF THE GARDEN

THE Royal Botanic Garden, Calcutta is situated on the west bank of the river Hooghly and is only a few miles from Calcutta. The Botanic Garden at Sibpur, near Calcutta, thus offers remarkable parallel to the Royal Botanic Garden, Kew, which is situated on the bank of the river Thames and is only a few miles from London. Both the gardens are of high scientific interest as well as of great aesthetic beauty. Both of them serve as source of inspiration, education and research for their many visitors. To quote Sir Arthur Hill's words, "May they find in them both spiritual rest and refreshment and also that tree whose leaves were for the healing of nations".

But the Royal Botanic Garden, Calcutta, has a different origin from its sister garden, the Royal Botanic Garden, Kew. The Kew Garden, which is younger than the Calcutta Garden by about fifty years, owes its origin to the interest in Botany of Royalty. But the Royal Botanic Garden, Calcutta, like many other overseas botanic gardens founded in later years of the 18th century, was founded with economic and scientific aims. Although the Royal Botanic Garden, Kew, with an area of 288 acres can at present claim to be the largest botanic garden possessing the largest herbarium in the world, it was started with only 15 acres of land in 1841. The Royal Botanic Garden, Calcutta, started with a little over 300 acres of land and at present occupies an area of 273 acres.

Col. Robert Kyd of the Bengal Infantry, the then Superintendent of the Hon'ble Company's dockyard and Secretary to the Military Board of Fort William, a keen horticulturist, suggested on the 1st January, 1786 to the Governor-General, Sir John Macpherson, then officiating in the absence of Warren Hastings, to form a botanic garden in Calcutta. Without further delay effect

was given to Kyd's proposal and with the subsequent approval of the Court of Directors in England, the present site then measuring about 310 acres immediately below Kyd's private gardens was acquired. Col. Kyd very appropriately was also appointed as the Honorary Superintendent and the work of developing this area into a botanic garden commenced with Kyd's valuable collection of exotic plants. The Garden henceforth became the property of the East India Company under the control of the Governor-General-in-Council. This is the reason why the garden is still known among local people as the 'Company Bagan'. The epithet 'Royal' came to be applied to it after the Queen's Proclamation of 1857. The control of the Garden apparently passed on to the local Government on the constitution of the Province of Bengal in 1834. Kyd continued to perform the duties as Superintendent until his death in 1793. A marble monument was erected in memory of Col. Kyd at the centre of the Garden.

Dr William Roxburgh, the Company's Botanist in Madras was appointed as the first official Superintendent in 1794. Roxburgh built the Superintendent's house in 1795. This house is now 145 years old. Roxburgh was the first to draw up a catalogue of 3500 plants then growing in the garden. This catalogue, '*Hortus Bengalensis*', in two parts was published after Roxburgh's departure from India in 1813 by his friend Dr Carey, the celebrated missionary. Roxburgh's '*Flora Indica*', his '*Plantae Coromandelianae*' composed in three volumes and his magnificent large portfolio coloured illustrations numbering 2382 embodied in 35 volumes prepared during the years 1794-1814 with the help of Bengali artists form the basis of Hooker's '*Flora of British India*' and many subsequent works on Indian plants. Roxburgh thus fully merited the title of "The Father of Indian Botany". The famous scientific society under the title of 'United Brotherhood' was established at this time by Roxburgh's preceptor John Gerard Koenig, a pupil of Carl Linnaeus, who was

the guiding spirit of Roxburgh's botanical studies in India. Sir William Jones who founded the Asiatic Society of Bengal in 1784 was one of the members of this brotherhood. Roxburgh died in 1815. A monument was erected in the Garden near the Great Banyan to perpetuate his memory.

Dr Francis Buchanan, (afterwards Sir Buchanan Hamilton F.R.S.) succeeded Roxburgh along with others. Sir Buchanan, an accomplished botanist and geologist was on special duty in connection with the development of agriculture in India and in the collection of materials for a gazetteer.

In 1817, Dr N. Wallich, an able and energetic botanist, was appointed and he held office until 1846. At this time the eastern portion of the garden measuring 40 acres including the teak plantation was given up by Government to the Lord Bishop of Calcutta (Dr Middleton) as the site for a Christian College known as the Bishop's College. This college since 1880 is the Bengal Engineering College, Sibpur. In 1836 about 2 acres of land were allotted to the Agricultural and Horticultural Society of India, which was founded in 1820 by William Carey, its first President. This area expanded to about 25 acres where the Society in co-operation with the garden officers conducted greater part of its agricultural and horticultural operations for about 40 years until 1872, when the Society's garden was transferred to its present site in Alipur.

Dr Nathaniel Wallich, F.R.S., undertook an extensive survey of a large part of the Indian Empire, particularly in the little known region of Kumaon, Nepal, Sylhet, Tenasserim, Penang and Singapore. His enormous collections were catalogued and named in Europe by himself and with the help of other botanists. They were then distributed to all the leading botanical institutions in Europe. A more or less complete set of this valuable collection however is still in the Calcutta Herbarium together with Wallich's voluminous irreplaceable catalogue and his correspondence from 1794 to 1829 which were transferred to the Calcutta Herbarium from the India House, London. Through the munificence of East India Company, Dr Wallich published his '*Plantae Asiaticae Rariores*', consisting of three superb volumes of illustrated coloured figures. Dr Wallich was not only Superintendent of East India Company's Garden but also Professor of Botany at the Medical College, Calcutta, and Superintendent-General of Teak Plantation in Bengal. Dr Wallich

retired in 1846 after thirty year's service and died in 1854. His friends and admirers raised a beautiful monument in respect to his memory.

Dr William Griffith officiated during Wallich's absence on leave and while on botanical expedition in Malaya died in 1845. Griffith's premature death deprived botanical science of one of its ablest and most meritorious votaries. Griffith's extensive notes and drawings were, after his death, published by Government in nine volumes. A marble monument in Griffith's memory was raised in the Garden.

Dr Wallich was followed by Hugh Falconer M.D., F.R.S., a palaeontologist, who held office till 1855. Early in 1858 during G. McClalloud's officiating period Sir Joseph Hooker visited the Garden on his famous journey to Sikkim and again on his return to Calcutta in 1860. Falconer was succeeded by Dr Thomas Thomson, M.D., F.R.S., a traveller and a botanist of much ability. Dr Thomas was the President of the Agri-Horticultural Society (1859-1860), the coadjutor of Sir Joseph Hooker in the collection and distribution of an extensive and well-known herbarium of East Indian plants and the joint author of the first volume of the *Flora Indica*. Thomas retired in 1861 and was succeeded by Dr Thomas Anderson, M.D., whose untimely death in 1870 was caused by a disease contracted during his effort for the introduction of the quinine yielding cinchonas into the Sikkim Himalayas. Dr Anderson was not only Superintendent of Royal Botanic Garden, Calcutta, and Professor of Botany but also the first Conservator of Forests for Bengal and in charge of the introduction and cultivation of Cinchona in India. For two years (1869-1871) subsequent to Anderson's departure from India, Mr C. B. Clarke, F.R.S., an officer of the educational establishments of Government of Bengal, the well-known systematic botanist and President of the Linnean Society, London, acted as Superintendent and during his incumbency he began a series of botanical publications on his vast collections of plants. He collaborated with Sir J. D. Hooker in writing *Flora of British India*.

In 1864 occurred the great cyclone of Calcutta. It was accompanied by a storm wave from the river Hooghly that laid the greater part of the Garden under water, in some places to a depth of six or seven feet, and carried two ships into the Garden with great violence. Over a thousand trees—at least one half of the total number in the Garden—and innumerable shrubs were prostrated. The survivors

were much shattered, and scarcely a vestige of leaf, flower or fruit remained. Three years later a less severe but still very destructive cyclone, in which over 750 of the surviving trees were blown down, completed the ruin.

In 1871 Dr George King, took charge of the Garden which was in a most unpromising state. The devastation wrought by the two cyclones had deprived it of all shade. A large extent was under coarse grass, and large parts were still, as they always had been, little better than swamps. Most of the roads were narrow, subject to flooding and unfit for vehicular traffic, while the present ornamental lakes were represented mostly by unsightly channel and 'tanks'.

Sir George after taking over charge set to re-making of the garden. The whole extent of the grounds has been raised in level, the necessary soil having been obtained from large sheets of ornamental water which have been cut out. These artificial lakes have been connected with each other by underground pipes, and a steam pump (and now an electric pump) has been supplied, by which the water in the whole system can be kept at a high level by means of water pumped up from the river. Many wide roads have been made all through the garden—so that carriages may be driven through every part of it.

The valuable collections of dried plants has been suitably housed in a handsome building designated by Mr E. J. Martin, the Government Architect, the internal arrangements of which are to a considerable extent adapted from those of the then new Herbarium building at Kew. New propagating houses, tool and potting-sheds have been erected, and good dwelling-houses have been built for the members of the garden establishment. A boundary wall and ditch have been partly built round the garden; and finally, attempts at landscape effects have been made in the gardens, and the collections have been increased by considerable accession of plants, both indigenous and exotic.

King made enormous and remarkable contributions towards Indian botany and initiated the publication of the world-famous *Annals of the Royal Botanic Garden, Calcutta*, in 1887. The second part of Vol. XIV of the *Annals* appeared this year. Sir George also moved the Government of India at this time for the establishment of the Botanical Survey of India which originated in 1890. The first *Record of the Botanical Survey of India* appeared in 1893.

The work of the Botanical Survey of India and the Garden with its Herbarium is so much inter-dependent that since the inception of the Survey in 1890 the Superintendent, Royal Botanic Garden, has been the ex-officio Director of the Botanical Survey of India. Botanical exploration is essential for utilising the vegetable resources of the country and maintaining the vitality of the Herbarium and the Garden. A glance at the map of India of the explored, unexplored and insufficiently explored regions will show what an enormous amount of work in this direction remains yet to be done.

In 1878, in succession to the late Mr Kurz, the reputed author of the "*Forest Flora of Burma*", Mr John Scott was appointed Curator of the Herbarium. On the 9th January of 1879, Mr Adolph Biermann, the Curator of the Garden met with a fatal attack by a tigress which, unnoticed by him or Mr Scott his companion, was crouching under shrubbery on the opposite side of the road. The tigress escaped from the menagerie of the ex-king of Oudh, swam across the river and landed in the Garden. Six weeks later a black panther also escaped from the same menagerie. This animal spent a night in the Garden and was shot by Dr G. King next morning before it had time to do any mischief. No such danger exists now.

Lt.-Col. (afterwards Sir) David Prain, who was first appointed as Curator of the Herbarium, succeeded Sir George King, Kt., F.R.S., K.C.I.E., who after 26 years of meritorious service retired in 1897 and became the Director of the Royal Botanic Garden, Kew. Before Sir David left India in 1904, he sketched out a geographical plan of garden divisions in accordance with which future plantings were to be regulated. Sir David Prain's plan, with slight modifications, continued to be carried on by his successors as opportunity allowed up to the present day. Sir David Prain's valuable voluminous publications are known all over the world. His botanical investigations proved to be of considerable importance to the State. He is now about 85 years old and has just finished his monumental works on *Dioscoriaceae* in collaboration with Mr I. H. Burkill, an officer of the Botanical Survey of India. Sir David Prain, M.A., D.Sc., Sc.D., LL.D., F.R.S., retired in 1906 and was appointed Director, Royal Botanic Garden, Kew. Lt.-Col. A. T. Gage who was first appointed as Curator of the Herbarium succeeded Sir David in 1906. A catalogue of non-herbaceous phanerogams cultivated in the Royal Botanic Garden, Calcutta, prepared by Lt.-Col. A. T. Gage, I.M.S., C.I.E., was published with the object of facilitating

the exchange with other botanical institutions of plants, seeds, or materials for systematic, anatomical, physiological or chemical investigation. Gage was also Professor of Botany, Medical College, Calcutta. He retired in 1923. During his absence on leave in 1908, Mr W. W. Smith (now Sir William Wright Smith, Regius Keeper, Royal Botanic Garden, Edinburgh, and Professor of Botany, University of Edinburgh) who was then the Curator of the Herbarium officiated as the Superintendent, Royal Botanic Garden. Subsequently Mr C. C. Calder, B.Sc., was appointed as Curator of the Herbarium after Smith. Mr Calder succeeded Lt-Col. A. T. Gage in 1923 and retired in December last year when the writer succeeded Mr Calder.

THE REGIONAL ARRANGEMENT OF THE GARDEN

In the open Garden there are about 15,000 trees and shrubs. In addition to these there are several thousands herbaceous species in the Palm-houses, Orchid-houses and Ferneries. The Garden, however, is by no means so rich in species as it might be, the total number of species in the open probably not exceeding 2,500. For some time the Garden fulfilled to a certain extent also the purposes of a Zoological Garden by having in it birds, deer, swans, monkeys and other animals. Still there is a colony of hill Moina living in the garden.

A scheme adopted 34 years ago was to treat the Garden as a map of the world on Mercator's projection representing the tropical floras. The plants of India and Burma are to occupy the central triangular area of the large western part of the Garden, this area being sub-divided in accordance with the geographical subdivisions of the Indian Empire. To the west and south-west of the large central Indian area are the divisions for North-west Asia, Europe, the America, Africa, and Madagascar, and to the east of it the divisions for north-east Asia, China, Japan, the Philippines, Siam and Annam, the Malayan Peninsula and Archipelago, and Australasia, the last five being separated from the large central Indian divisions by the special collections of palms, screw-pines, and bamboos. Scattered throughout the Garden are twenty-six irregular lakes, some of which are of large extent with islands. Altogether the lakes comprise about one-ninth of the total area of the Garden. Most of them were designed by King with such skilful diversity of outline and surroundings as very greatly to enhance the beauty of

the Garden. The Garden contains more than 10 miles of roads which have been recently macadamised.

The Garden which is open from sunrise to sunset daily is now accessible both by roads and by the river. Communications have been made much easier than what they were about 50 years ago. Passing through the Oreodoxa Avenue, from the river gate one reaches the Orchid House, the Large and the Small Palm Houses where in artistic beds selected ornamental and delicate herbaceous species and rare



OREODOXA AVENUE IN FRONT OF THE RIVER GATE.

palms are on view. The Asiatic palms have all been monographed by Dr Becarri and O. Martelli in the *Annals of the Royal Botanic Garden*, volumes XI, XII and XIII.

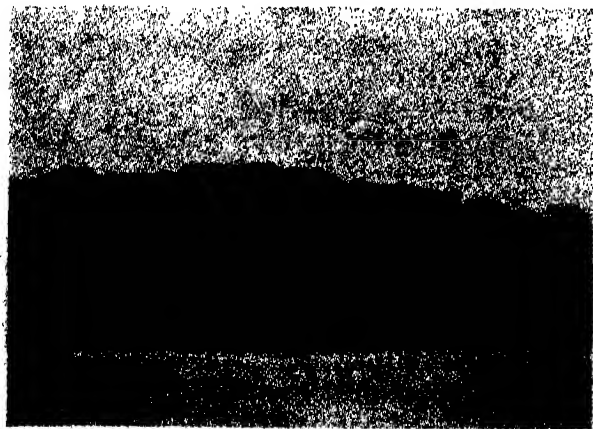
Coming out of the northern gate of the Orchid House a visitor will find himself among conifer group, adjacent to the flower garden.

Turning towards the Palm Avenue one reaches the Palmatum. Within the close range of the Palmatum two other avenues are seen—(i) Mahogany Avenue and the (ii) Albizzia Avenue. To the right of the Mahogany Avenue lies the Bambusetum. The bamboos of India have been monographed by the late Mr J. S. Gamble of the Forest Service in the *Annals of the Royal Botanic Garden, Calcutta*, Vol. VII, 1896. Many rare species of bamboos of great economic value are still under cultivation in the Garden. Here in the Bambusetum are seen clumps of *Melacanna bambusoides* with the large apple like germinating seed. This bamboo known as *Muli Bans* is much used for building purposes,

basket work and various other domestic needs. This species is distributed in the eastern part of India from East Bengal to Tenasserim in South Burma.

Within the close range of this area are visible some of the rare plants, which flower once in their lifetime and then gradually die like many of the bamboos. Agave (Century Plant, American Aloe *A. fourcroydes*) in which 2-3 leaves are formed in a year during 5 to 100 years, finally a gigantic terminal inflorescence comes out of the centre. There is so great a rush of sap on the inflorescence that the Mexicans cut off the flower heads and collect as much as 1000 litres of sap which is fermented and is used as a national drink. Many yield useful fibres. The species (*A. sisalana*) Sesal hemp is cultivated in Bhamas and India for fibres. *Corypha umbraculifera* L. (talipot palm) of South India grows to a height of 80-100 ft. The gigantic terminal inflorescence bursts out of its massive spathe with a loud explosion and the prolific panicle gradually unfolds. The leaves are used as umbrellas, for thatching and as writing material.

From the river gate to the left of the Oreodoxa Avenue runs straight the Banyan Avenue and the visitor can reach the Great Banyan after 5 minutes' walk from the river gate. The Great Banyan in the days of its full juvenile glory looked more like a forest in miniature than a single tree. The Great



THE GREAT BANYAN TREE—GENERAL VIEW WITH THE AERIAL ROOTS.

Banyan is now 171 years old. The crown is 1100 ft. in circumference and there are about 666 aerial roots actually rooted in the ground. In 1895, the girth of the main trunk was 51 ft. The tree suffered to a certain extent during the cyclones of

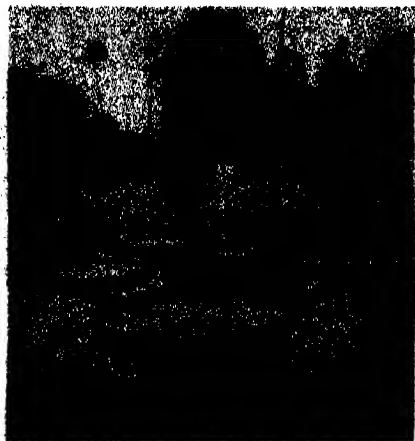
1864 and 1867 and some of its main branches were broken and thus exposed the tree to the attack of a hard fungus which was subsequently identified as *Fomes pachyphlaeus* Pat. by Dr S. R. Bose and was for the first time reported by him from Bengal. This attack finally led to the deterioration of the trunk where the fruit body as large as 60-90 c.m. long and 30 c.m. broad and 8 c.m. thick developed at different heights of the trunk. During the rains when the rays of the sun happened to reach the body of this perennial fungus, masses of spores were seen discharged from it. Sometimes so dense was this smoke of spores that it was visible from a distance as a cloud overhanging the tree. Slides exposed over the tree revealed that the colour was mainly composed of spores of the fungus. The trunk thus decayed was subsequently attacked by insects too. Therefore there was no other alternative but to remove the main trunk some time after 1920 in order to save the major branches. Series of operations were performed and by grafting a daughter-tree fresh energy has been infused. The tree has thus been saved from total destruction. Attempts are being made now to fill up the central gap and to extend the branches across the road round the Banyan circle like a canopy overhead. The tree is flourishing quite well.

There are many plants which behave curiously and sometimes create much interest both for the botanists and for the laymen. These are (i) *Ficus* and date-palm; (ii) breathing roots of *Taxodium distachyum* and *Heritiera minor*; (iii) plank buttresses of *Sterculia alata* along the Scott Avenue. To the northern end of the Avenue under *Kigelia pinnata* Mr Biermann was mauled by a tigress in 1878; (iv) the bud mutation of *Ficus Krishnae*. This tree is named after Lord Krishna who is supposed to have twisted the leaf into an ascidiform structure. The tree reverted to the character of its parent—*Ficus bengalensis* after about 30 years. It cannot therefore claim a specific rank. The tree (*F. Krishnii*) had its origin from a graft made out of a branch bearing the abnormal leaves. When propagated from the graft this tree has always the character of its scion. But when raised from the seeds it is only about 10% that develop the funnel shaped leaves.

In some lakes of the Garden are grown aquatic plants of much interest. Recently limnological investigation particularly of the fresh static waters in Bengal is engaging my attention. Researches in

this direction are of far-reaching importance in tackling many an intricate problem of sanitation, water purification, filter works, irrigation and of public health. In Bengal most of our jhills, swamps, lakes, tanks are choked up with aquatic vegetation. If the water plants are properly controlled, a considerable headway can be made towards ample

Herbarium serves the purpose of studying the East Himalayan plants on the spot. The Lloyd Botanic Garden has been largely instrumental in acclimatisation and investigation of Himalayan plants and particularly in improving the town of Darjeeling by way of introduction of many economic plants and foreign species of great horticultural interest.



VICTORIA REGIA AS GROWN IN THE EDEN GARDENS.

supply of pure wholesome water in the villages. In the lakes of the Garden many aquatic plants of horticultural, economic and medicinal importance are cultivated. Of special interest are *Victoria regia* and *Victoria Curziana*—the Giant Amazon lilies taken as a whole (see next page).

Different sections under the administrative charge of the Superintendent, Royal Botanic Garden, Calcutta, as sketched in the accompanying table (facing next page) will give an idea of the various activities of this institution as a whole.

THE LLOYD BOTANIC GARDEN, DARJEELING

In 1878 a botanic garden was laid out at Darjeeling by the efforts of Sir Ashby Eden, the then Lieutenant Governor of Bengal. It is named after Mr William Lloyd, who made over to Government 40 acres of land within the Darjeeling station. The garden developed under the guidance of Sir George King. In this garden in an area of 40 acres are represented in miniature the temperate flora of the world with special reference to submontane, montane and Alpine flora of the Himalayas. This is the well-known centre for the distribution of Himalayan seeds and plants in India, and with its

HERBARIUM

The Herbarium and the Library have gradually developed since the foundation of the Garden in 1786. The present damp-proof and fire-proof building especially designed to house nearly two and a half million authentic sheets of Herbarium specimens which form the basis of all botanical and allied investigations was erected in 1883. In this Herbarium all these precious sheets consisting of irreplaceable types, cotypes, lectotypes, ecotypes, etc., are arranged in proper scientific order. The Herbarium is thus the depository of a very complete collection of the dried materials of plants of the whole of the Indian Empire as also fair collections of those of Asia outside India, of Europe and Australia. Plants of Africa and America are partly represented. For the systematic botanists, forest officers, herbalists,



EXTERIOR VIEW OF THE HERBARIUM.

druggists, pharmacologists, industrialists and others interested in plants, the Herbarium is the most interesting and valuable spot in Asia. This is the only place for botanical investigation of its kind in India and is recognised as the best Herbarium not only in India but also in the East by the international

botanical organisation of the world. This Herbarium is, as Sir Arthur Hill, Director, Royal Botanic Garden, Kew, puts it, "the Mecca for the study of Indian Systematic Botany by botanists not only in India but from overseas". It will be interesting to note here what Sir Richard Temple, a Lieutenant Governor of Bengal said on the utility of a herbarium as early as 1876, "The collection is and will always be most useful in dealing with questions regarding the naturalisation of plants, the introduction of new vegetable products into the country, the adaptation of raw produce to the growing requirements of manufacturing industry, the management of the forests and the scientific improvement of Agriculture." Introduction of quinine, rubber, Ipecacuanha, various timber trees, fibre and oil yielding plants and other plants of great economic value is mainly due to exploration by the scientific officers of this Garden. The task of plant-hunting is by no means an easy job. In the inaccessible places it is hazardous and sometimes costs the life of the explorer. Dr T. Anderson lost his life in introducing cinchona into this Province. The cinchona cultivation in Bengal was first started by him in Sinchal. Then it shifted to Rungbee and finally the plantation was located in Mungpoo where the conditions proved favourable for wider cultivation and further extension.



INTERIOR VIEW OF THE HERBARIUM (GROUND FLOOR).

Besides quinine, various other useful plants like jute, tea, potatoes, coffee, spices, sugarcane, flax, hemp, rhea, sisal hemp, tobacco, cocoa, rubber, indigo, fodder grasses and numerous other economic plants were introduced through this Garden. Almost all the road-side trees and ornamental

garden plants now found widely grown all over India and Burma were first acclimatised in this Garden. These were then distributed all over India and abroad. Of recent introduction is the Tung oil tree which is a source of considerable revenue in China. Experiments at this Garden indicate possibilities of cultivation of Tung oil in suitable areas of Bengal and



INTERIOR VIEW OF THE HERBARIUM (UPPER FLOOR)—IN THE RIGHT-HAND SIDE ARE SEEN WALLICH'S CATALOGUE AND A SKETCH OF ROXBURGH'S ICONES.

Assam in the drier lower ranges of the Himalayas between 2000-5000 feet. Reports of successful cultivation from Assam, North Burma and some parts of Bihar are promising. There is no reason why India should not be made self-supporting with regard to the supply of this oil so useful for various industrial purposes. The Garden distributed half a ton of seeds received from Kew to various parts of India with view to acclimatising Tung oil yielding trees. Some ornamental plants of recent introduction are *Victoria Curziana*, *Erythroxylon coca*, (cocaine plant), yellow lotus (North American *Nelumbium luteum* Willd.), *Musa rosacea*, *Cympogon Martinii* (Citronella oil yielding grass), *Durio* (*Duriozeblithenus*) the Burmese fruit tree.

On the 6th January, 1938, the 150th foundation anniversary of this Garden was held, which happily coincided with the Silver Jubilee Session of the Indian Science Congress held in Calcutta. Many distinguished botanists took part in the celebration of the sesquicentenary of the Garden. Encouraging messages and greetings wishing prosperity to the Garden were received from far and wide.

Late reputed Prof. Hans Molisch, while working at the Bose Institute during 1928-29 as a guest of our

great scientist, the late Sir Jagadish Chunder Bose, D.Sc., F.R.S., used to spend long hours in the garden pondering over many of his intricate botanical problems whose solutions he believed to have found under the sylvan surroundings of this Garden. The Garden to him, as he expressed it, was "a paradise, a wonderfield for botanists where life of every species grown under a tropical climate offers problems of careful investigations".

Prof. E. J. Salisbury in the concluding remarks of his presidential address in 1937 at Nottingham before the British Association for the Advancement of Science rightly observed, "A sympathetic understanding of botanical thought and progress is essential to a community which is to deal adequately with such national problems as agricultural policy, land utilisation, afforestation, drainage and water supply, the preservation of rural areas or the provision of national parks". The long records of the achievements of this Garden clearly show how far this Garden has contributed towards these items of nation-building works. But considering the vast needs of the country much remains yet to be done.

It is gratifying that a young and enthusiastic body of brilliant Indian botanists is being turned out

through the gradually enlarging scope of specialisation of the Indian educational system. It is also encouraging that some of the work done by those men is now of a standard that is gaining recognition in the world of botanical science and there is no doubt, it is always gaining in importance. But this is the better reason, why the historical living and herbarium collections of the Botanic Garden that come down to the new schools should have the same care, attention and study that was formerly given to them. In the eyes of the scientific world of tomorrow it will take much more than a plea of financial stringency to justify the neglect today of priceless irreplaceable objects of art and science that have come down as treasure to us. I hope, as my predecessor hoped, for a brighter prospect to dawn in the future and enlightened recognition by both the public and those in authority of the great possibilities of this unique botanical institution in India, if not in the East.*

* Published with the kind permission of the Trustees of the Indian Museum, Calcutta, where the lecture on the Royal Botanic Garden, Calcutta, was delivered under the auspices of the Trustees on the 15th March, 1940.

INSPIRATION FOR RESEARCH

GREATER even than the greatest discovery is it to keep open the way to future discovery. This can only be done when the investigator freely dares, moved by an inner propulsion, to attack problems not because they give promise of immediate value to the human race, but because they make an irresistible appeal by reason of an inner beauty In short, there should be in research work a cultural character, an artistic quality, elements that give to painting, music, and poetry their high place in the life of man.

—John Jacob Abel

Notes and News

House-heating by Solar Energy

THE problem of utilisation of radiant solar energy has been in the mind of scientists for a long time. Now and then construction of solar engines has been suggested and even made practicable, though none has been utilised so far. Some real progress is expected to be achieved in this direction in the near future as the Massachusetts Institute of Technology has taken up the problem of house-heating by solar energy with the aid of a gift of 650,000 dollars from Dr Godfrey L. Cabot. The energy received by the earth from the sun amounts to about $\frac{3}{4}$ of a horse-power per square yard, the amount somewhat varying with the latitude. The amount of solar energy received anywhere on the surface of the earth (except at the poles) varies from zero to a certain maximum during the course of the day and in order to have an unfailing and uniform supply some feasible storage system is necessary. If efficiently stored and used the solar energy received by a house in mid-latitudes is sufficient for house-heating. Theoretically there are many ways of storing the solar energy—as heat, as chemical energy, as electric energy or as potential mechanical energy. For various reasons the storage of energy in the form of heat appears to be most promising. Something will absorb the solar energy as heat when the sun shines, store it safely and economically and deliver it whenever required. The scientists at Massachusetts Institute of Technology has chosen water as the storage material. The problem of getting solar energy into water and preventing its escape until it is required is really a difficult one but the workers engaged on the problem are quite optimistic about arriving at a solution. Just at present there is no prospect of solar energy competing with coal or petroleum for our everyday purposes. But eventually coal and petroleum will be exhausted and scientists will have to find out substitute sources of energy of which the sun appears to be the most promising. An account of the earlier pioneer work on the utilisation of solar energy is published in the Science in Industry section of this issue.

Million Volt X-Ray Tube

IN the treatment of cancer and other diseases where gamma-rays or 'hard' X-rays have to be used, the use of gamma-rays has now been almost confined to treatment where the source of the rays can be introduced into or placed in intimate contact with the diseased tissue. This is because of the low gamma-ray intensity even when a large dose of radium is used. On the other hand, the penetrating power as well as absolute intensity of the beam can be suitably increased in the case of X-rays by raising the voltage applied to the X-ray tube and this permits the patient to be located at a greater distance from the tube. These considerations have led to the development of an one million volt X-ray tube in the Mozelle Sassoon X-ray therapy department of St. Bartholomew's Hospital, the output from which is approximately equivalent to that obtainable from £8,000,000 worth of radium. In order to afford protection from unwanted X-rays the apparatus-rooms and treatment-room are enclosed in walls of barium sulphate concrete, whilst the control room is separated by an eighteen inch thick wall of barium-sulphate concrete. Patients are observed from the control room by means of a periscope system of mirrors. In the treatment-room all that can be seen of the equipment is the large horizontal steel tube, spanning the full width of the room and provided with a central aperture through which the X-ray beam emerges. This steel tube is a protective shield in the form of a double walled cylinder surrounding the X-ray tube proper and filled with lead shot six inch thick to cut off all X-rays except those directed on to the patient. The X-ray tube itself consists of a fourteen-inch diameter steel tube, seventeen feet in length, on the horizontal axis of which are located the cathode and anode, mounted on steel support-tubes and operating in a high vacuum. The cathode head is provided with six interchangeable filaments, any one of which may be brought into operation immediately in the event of a failure, without evacuating the tube freshly which would require about two hours. From the filament, streams of electrons

shoot out and are accelerated through a potential difference of 300,000 to 1,000,000 volts to bombard a gold and copper target on the anode from which the X-rays are projected. A closed water-cooling system, comprising a radiator and fan dissipating ten kilowatts is employed to produce artificial cooling of the anode. In order to maintain high vacuum in the tube, continuous evacuation is employed by means of high speed Apiezon oil-diffusion pumps backed by mechanical pumps. During the two years that the tube has been in operation it has been energised nearly for 2,800 hours.

More about Magnetic Mines

ALMOST everybody is familiar with the word "Magnetic Mine" but to many its working principles have not been made absolutely clear. As in the *Arabian Nights*, where it is described in a story that the nails and other iron parts of the ship of Sinbad, the sailor, were pulled out from their places by the force of attraction of a magnetic hill in the sea, the general belief is that due to the attraction of the ship's iron the magnetic mine rises from the bottom of the sea, and the explosion takes place on impact with the ship's bottom. But the working principle and the mode of explosion of the magnetic mines are quite different.* These mystery mines are of two types: first the inert shallow-water type; and second the mobile deep-water type. They are very light and can easily be dropped into the sea from a height of 100 to 200 ft. from the water level by aircrafts, without damaging its mechanism or without detonation. Both the types have three distinct compartments. The upper one or the head contains a battery, a magnetic grid or device, and several other delicate electrical circuits and pressure valves. The middle compartment contains the explosive with the detonator caps. In the mobile type in the hind portion there is a bottle of compressed air, the mouth of which is connected by complex electrical circuits to the magnetic grid. The inert type has no compressed air bottle. The extra space in the hind compartment is filled up with water when the mine is dropped into the sea, in consequence of which it sinks.

When a ship comes within a certain range, the ship's iron bottom actuates the magnetic grid, which closes the electrical circuit, thus releasing the compressed air. This air forces out the water from the hind portion, and the mine, being now lighter than water, begins to rise. When at a distance of about 50 ft. from the sea level the detonator circuit is closed

by a pressure release valve and the mine explodes, the effect being that of a depth charge. It does not really strike the bottom of the ship. The mobile types are suitable for deep seas from 200 to 400 ft. depth. The inert type does not rise from its place at the sea bottom. When the ship comes just above it, the magnetic grid closes the detonation circuit and the explosion takes place at the bottom of the sea. This type is suitable for shallow waters up to 50 ft. depth.

The difficulty against these mines is that the existing mine detectors or sweepers are quite ineffective against them. Though precise details, for obvious reasons, are not disclosed, it is now known that the British Admiralty has been able to develop a device, which, it is believed, will constitute efficient protection for steel ships against the form of magnetic mines at present being used by the Germans. The device is known as the "De-gaussing girdle" and consists of insulated electric cables, energised in an undisclosed manner by electric current. The de-gaussing girdle neutralises the natural magnetic field of a steel ship and renders her as safe from the magnetic mines as is a wooden ship. It is applicable to ships of all sizes, though the details of the treatment vary from ship to ship. When the *Queen Elizabeth* arrived at New York a conspicuous girdle around her hull attracted notice, and it has since been known that all British ships are to be so fitted as quickly as possible. Some time ago it was announced in the press that arrangements had been made at the Calcutta docks to fit the ships with the de-gaussing girdles.

N. K. S. G.

World Catalogue of Meteorites

A WORLD catalogue of meteorites, the largest and most comprehensive of its kind yet published in any country, which should prove of use to those interested in these extra-terrestrial arrivals, has just been brought out as a *Memoir* by the Geological Survey of India. A special reference is made in the publication to the Indian falls and finds and to specimens exhibited in the Indian Museum, Calcutta.

Three hundred and ninety one of the 1,258 meteorites listed in the Catalogue are recorded from the United States of America. This is by far the greatest number for any country. India ranks second with 116 meteorites and it is followed in order by the U. S. S. R. 98, Australia 95, France 57, Mexico 53, Chile 40, with South Africa, Germany and other countries less than 36 each. The *Memoir* deals with questions of "craters" caused by meteorites and "showers" of meteorites, and also with the origin of meteorites.

* An earlier account of these magnetic mines was published on p. 623 of the April '40 issue of this journal in this section.

Portions of extra-terrestrial bodies, meteorites, are the only tangible source of our knowledge of the universe around us. There are two chief kinds, *irons*, composed mainly of nickel-iron, and *stones*, composed mainly of silicates; but there is every gradation between them. They contain mainly elements of low atomic weight—which means they do not contain heavy metals like gold and platinum. Their average composition indicates matter which would have a density near that of the earth as a whole, *i.e.*, about 5 where water is taken as 1. The largest meteorites are all *irons*, the largest known mass at Hoba in South-West Africa weighing 54 tons. The largest known *stone* meteorite fell at Long Island, Kansas and weighed 1,275 lbs. The immense masses of the large meteorites, the impact of which on the earth has been responsible for the formation of remarkable craters, can only be conjectured. Most of iron meteorites which have been found were not observed to fall. On the other hand, most stony meteorites have been seen to fall. No human being is definitely known to have been killed through the fall of meteorites.

It is estimated on the measurement of helium content that the oldest known iron meteorite solidified 2,900 million years ago. It has also been estimated that if meteorites are scattered portions of our solar system, their age should not be greater than 3,000 million years; but if they come from other stars, their period of solidification might date back some 10,000,000 million years. The determined date of solidification of iron meteorites thus accords with the assumption that they belong to our solar system.

Temperature Forecasts in India

TEMPERATURE forecasts are now being included in the daily weather reports of the India Meteorological Department. Forecasts are prepared by the Meteorological Officers at Poona, Calcutta, Karachi, and Delhi. Temperature and humidity affect the well-being of men, animals and plants. Forecasts of abnormal temperatures are of use to the general public as well as to the agriculturist, the engineer, the medical man and probably also a progressive industrialist.

Timely warnings of cold waves to agriculturists can lessen the losses arising from frost. A small expenditure on preventive measures, *e.g.*, by providing wind-breaks and burning heaters in orchards may enable a farmer to save his crops. Usual heat waves sometimes scorch up crops. It is possible that the bad effects of these may in some regions be minimised by timely irrigation.

Forecasts of incidence of low and high temperatures were previously given in the daily weather

reports between 1890 and 1905. In 1905 there grew up a tendency to shorten all reports and accordingly to drop out forecasts of temperature which disappeared from the reports between 1906 and 1928.

In the winter of 1928-29 the occurrence of an unusually intense cold wave induced the Meteorological Department to revive the old practice of including the temperature forecasts in the reports whenever large changes of temperature were expected. In the winter of 1936-37 warnings for low temperature began to be sent to a large number of officers, mainly agricultural, in those provinces and States where crops are liable to be affected by frosts.

Kodaikanal Observatory Report

A FURTHER fall in solar activity is reported in the annual report for 1939 of the Kodaikanal Observatory, which specialises in the study of the sun. Observing conditions were slightly more favourable for solar observation than in 1938. The daily mean number of sun spots remained the same as in 1938. There was a decrease of 39 per cent in the mean daily areas of calcium prominences and a decrease of nine per cent in their mean daily numbers. A study of prominence areas was made to determine the possible influence of the earth on solar prominences.

Photographs of the sun on a scale of eight inches to the sun's diameter were obtained on 330 days and photographs in the lights emitted by calcium and hydrogen on the sun on 317 and 284 days respectively. Photographs showing solar prominences were taken on 305 days. Some of these photographs were supplied to Observatories at Greenwich, Cambridge and Meudon. The bright eruption on the sun on March 3 could be photographed in its successive stages. During the months of August and September, the sun showed unusual activity. These, as well as selected Fraunhofer lines, formed subjects of special study. A theoretical investigation on the mechanism of solar dark markings was also undertaken.

An amplifier to the photo-electric microphotometer at the Observatory was constructed and fitted up. The Observatory carried out the programme of the International Astronomical Union. The Milne-Shaw seismograph recorded 193 earthquakes during 1939.

New Water Level Recorders

TWO automatic recorders, one for use in seepage drains and another for recording fluctuations of supply channels, have been designed by a Punjab engineer. The seepage drain recorder which is

known as 'Cam' Recorder is entirely self-contained. The drum on which the chart is placed is driven by clockwork filled with jewelled escapement and will run for one month for each full winding and the recording pencil will last for the same period. The chart moves forward at one-tenth of an inch per hour and three days recording will be seen at a glance.

The other instrument which is called 'Zem' Recorder can be set to operate either at the head or tail of a supply channel. The pencil operating on the chart of the instrument can be set to the correct indent and fluctuations in the supply are recorded either above or below the line in the centre. The range can either be six inches up and six inches down or three inches up and three inches down. The chart moves at the rate of one-tenth of an inch per hour and one roll will last twelve months. The drum on which the chart is placed is driven by a one-second electric pendulum clock actuated by a battery of five dry cells and will run for at least six months without attention. The recorder can be allowed to read up to 14 feet range by fitting in differently pitched screws. The float arrangements for both gauges consist of an eight-inch copper float fitted in a twelve-inch light steel tube and cannot be tampered with. This tube requires a twelve-inch square well or can be placed in an open channel.

Report of the Imperial Agricultural Research Institute

SCIENTIFIC REPORTS of the Imperial Agricultural Research Institute for the year 1939 have been just published. The research for types of wheat is being carried on at the Institute and in one of the preliminary tests an increase in yield by about 200 lb. per acre in bulk plots has been recorded. Work on the breeding of wheats resistant to rust and loose smut was continued at Simla and preliminary trials showed a number of successful hybrids. Studies in other crops, particularly on tobacco, potato, oats, rice, etc., were continued. Experiments are in progress, both in Delhi and Simla, in the breeding of disease-resistant varieties of potato. This crop is subject to numerous diseases both while in the field and in storage. Among a large collection of Indian varieties, over 300 samples were studied and classified into groups after elimination of synonym stocks. Experiments in shortening the rest periods of potato are also being continued.

Work on the fine-curing of tobacco and experiments to determine the effect of chemical fertilisers and the rotation of crops on the quality of cured leaf are in progress at Guntur. In order to produce strains combining a good yielding capacity with high

nicotine content, crosses between suitable types have been made and the results so far obtained are encouraging.

The Coimbatore Sugarcane Research Station has evolved a sugarcane-bamboo cross, which is of great importance both from the scientific and economic points of view and the trials, though still in the initial stage, are yielding encouraging results. Varieties of cane suitable for different cane-growing tracts of India have been evolved at the Coimbatore Station and some of the new productions obtained by careful combinations of thick and medium varieties bid fair to excel the earlier types both in adaptability and performance.

A finding of outstanding importance, both from the point of view of production and human nutrition, was that manures and fertilisers, when properly applied, were capable of influencing the quality and composition of the crop to such an extent as to affect appreciably its value both as seed and food. The importance of the discovery, particularly in India, where a major part of the soil is poor in organic matter and where in many cases one variety of grain forms the staple food of the bulk of the population, cannot be overestimated.

Experiments with different types of fertilisers and manures were continued. Correlated with these investigations were the studies undertaken on plant nutrition in general and, in particular, on the effect of soil conditions and fertilisers on plant metabolism.

The Institute has devised a combined furnace (New type 938) for gur and carbon manufacture at a construction cost of only Rs. 100. It will accommodate both the processes of carbon manufacturers and open pan-boiling within a compact space of 30 by 20 feet and will provide for the better utilisation of the heat of the flue gases. It has considerably helped to make further reduction in the cost of carbon, which can now be produced at less than a pice per pound.

Ten students completed the post-graduate course during the year and were granted the diploma of the Institute. The one-year course in farm organisation and general farm engineering was completed by five students. Nine students and a few officers deputed by provinces and universities were given short training in special subjects. Besides, 11 honorary workers were admitted for research on definite problems.

African Race and Culture in Photographs

MR A. M. DUGGAN-CRONIN, an employee of the De Beers Company in Kimberley, came in contact with the different types of African people who came to work in the mines. His interest was

aroused by their difference in culture and features and he made up his mind to make a photographic record of these people. From 1904 he began to collect photographs of the different South African racial types. Later on he added photographs of cultural traits too. With the help of the Union Research Grant Board and the Carnegie Institute he visited systematically different parts of South Africa year after year since 1925, and collected interesting objects of native use. The number of these photographic records has come up to 2600 at present, a part of which he has already published in the form of books with short notes.

In 1938 he made over his collection of photographs and ethnographic objects to the town of Kimberley and the Duggan-Cronin Bantu Gallery was opened in a building of the De Beers Company. At the joint meeting of the Rhodesia Scientific Association and the Rhodesia Photographic Society, held recently at Salisbury, this collection was very highly appreciated. A similar collection is not impossible in India, and if effected, would help to a very great extent in giving us a correct view of the life and culture of our primitive tribes (about 25 millions) about whom utterly conflicting ideas are held even by our educated public.

T. C. D.

Announcements

THE Government of India have revised their rules for the award of a State scholarship, ordinarily tenable for three years in Great Britain, which is awarded every year. Qualified students, without restriction of sex, race or creed, not ordinarily more than 30 years old on January 1 of the year in which the award is made, who are by birth or domicile natives of a territory under the administrative control of the Government of India or any administered area in an Indian State, are eligible for the scholarship. The scholarship will be awarded only for special purposes, *viz.*,

(a) training for particular posts such as those in special institutions like schools for defectives ;

(b) preparation for some particular work, *e.g.*, inspection of girls' schools, examination of educational systems or types of training etc., and

(c) study in any branch of knowledge for which suitable facilities do not exist in India.

The value of scholarship awarded will be as follows :—

At Oxford or Cambridge (Collegiate)	£335 per annum.
At Oxford or Cambridge (Non-collegiate) ...	£300 per annum.
At universities or colleges other than Oxford or Cambridge ...	£216 per annum exclusive of fees and sanctioned travelling expenses which will be payable in addition.

The selected scholar will be provided with fare from his or her home to the place of study. Similar facilities will also be allowed for return home provided the scholar has complied with the rules. The selected scholar will be required to execute a bond undertaking to pay a sum of £1,000 (or, in India, its equivalent in rupees) if he or she fails to return to India when directed or if he or she settles in some other country within five years of the termination of the scholarship.

THE University of Bombay have conferred the degree of Doctor of Science on Prof. Maneck B. Pithawalla for his Geographical Studies of the Lower Indus Basin (Sind). This is probably the first instance when a person has been admitted to the doctorate degree in recognition of his researches in geography with reference to India. Dr Pithawalla has a number of publications to his credit, mainly with reference to the geography of his own province, Sind. He worked for sometime under Professor E. G. R. Taylor in London.

THE Governing Council of the Indian Institute of Science have approved of an industrial research scheme involving Rs. 1¼ lakhs as additional expenditure for two years as an emergency war measure. The proposed researches relate to manufacture of fertilizers, synthetic drugs and artificial plastics.

PROFESSOR B. N. SINGH, Head of the Institute of Agricultural Research and Professor P. S. Varma, Department of Organic Chemistry, Benares Hindu University, have been appointed Local Secretaries of the next session of the Indian Science Congress Association to be held at Benares in January next. Professor M. R. Siddiqi of Osmania University and Mr C. C. Inglis, Director, Central Irrigation and Hydrodynamic Research Station, Poona, have been elected presidents of the mathematics and statistics and the engineering sections respectively of the Benares session in place of Professor K. Anand Rao and Sir M. Visvesvaraya who have expressed their inability. In the geography and geodesy section Dr S. M. Tahir Rizvi of Aligarh University will preside.

SCIENCE IN INDUSTRY

Glass Fabrics in Electrical Industries

THE use of glass textiles as insulators in motors and generators is increasing very rapidly. Glass fabrics have been proven stronger not only at normal temperatures but also at elevated temperatures. At temperatures around 200°C all organic materials deteriorate very rapidly and soon lose practically all mechanical strength, even the asbestos fabrics which usually includes some organic ingredients slowly lose their strength, but glass fabrics do not. Glass fabrics do not become brittle until they are heated to about 700°C and do not soften below 800°C. The above temperatures are far above the operating conditions of motors and generators.

The glass fabrics are non-hygroscopic and consequently have higher insulation resistance than other materials when exposed to highly humid air. One of the causes of the deterioration of silk etc., is this absorption of moisture. The resistance of glass fabrics to attack by acids, oils, corrosive vapours and vermins are of obvious advantage where these hazards exist. Of course with respect to dielectric strength and other properties glass insulators in its present form is not comparable to mica.

Glass fabrics have greater thermal conductivity, this means that for a given flow of heat the temperature difference between the inside and the outside of the insulation is less, with consequent lower internal temperatures.

The finish taken by glass insulated machines are excellent and the machines look very decent in appearance. But glass has its disadvantages too. Its resistance to shearing against sharp edges is low. Although most of the characteristics associated with glass have been modified, it is still fundamentally glass and its inherent brittleness is evidenced in this manner. So in order to use it sharp edges must be avoided.

N. K. S. G.

Spraying Surfaces with Shellac

A new process for coating surfaces with shellac, by spraying it from a heated "pistol", has been evolved in the Chemical Engineering Department at

the University College in London by Mr K. B. Lalkaka, on behalf of the Indian Lac Cess Committee with the co-operation of two British research workers.

The process is applicable to many commercial purposes, such as the spraying of wood, paper, tin, aluminium and copper sheet, concrete, glass, asbestos board, plaster castings, and porous stoneware; for anti-fouling compositions, laminated insulation and coatings for storage tanks containing edible fats or corrosive mineral oils. The spraying of lacquers, and even of metals, has been employed for some years, but this is the first process which has enabled the application of a resin direct, without using solvents, thereby saving time, labour and expense.

The film is hard as soon as it is cold, and thus the usual drying time is eliminated. This property will be of great value in many industries. Among other advantages are the saving of time and labour, owing to the speed with which a coat of shellac can be applied; and the saving of expense, owing to the fact that solvents are no longer required.

More Salt from Sambhar Lake Area

ROUND the Sambhar Lake a vast area has been discovered from which the salt is now being scraped out. It was so long dumped with the refuse liquor of the surrounding *kyars*, or collection of manufacturing pans.

It is anticipated that on the edge of the area where crystal salt has been discovered, there is about 10,00,000 maunds of powdered salt. The existence of a thick deposit of *reshia* or powdered salt along the edge is, it is explained, due to action of westerly winds and the consequent rapid precipitation of fine salt as is met with on a smaller scale in the *kyars*. Till now a quantity of 4,50,000 maunds of *reshia* has been collected, which is being despatched to the stores after washing. About 5,00,000 maunds of salt of this kind is still lying there in admixture with some grained salt.

Ordinarily, after the rains, this bitterns area remains covered with brine practically throughout the year, but this year, owing to deficiency in rainfall, the whole of the deposit lay exposed and its explora-

tion led to the discovery by Mr Rahim Baksh, a Superintendent in the Northern India Excise and Salt Department at Sambhar, of a regular layer of crystal salt of good quality about three inches in thickness, beneath one inch to two inches thick crust of impure salt, which was easily removable from the top. On excavation by normal methods the layer breaks up easily into separate and well matured crystals, medium and large in size, and absolutely white in colour. Washed with condensed brine, the salt attains a purity which physically and chemically compares very favourably with the ordinary salt manufactured or mined in India, or imported from abroad, the percentage of sodium chloride varying between 95 and 99. The collected salt after being washed with canal brine is carried to the Central Stores of the Sambhar Lake by meter-gauge trucks hauled by a railway loco.

Solar Rays as Source of Power

Of solar radiation which we receive, 15 per cent has the possibility of being converted into mechanical work. Similar to hydroelectric power which we generate from natural water sources, solar power demands no continuous expense except care and interest on the initial investment. The only drawback is that solar power ceases during night hours and on cloudy days. For irrigation purposes however this intermittence is not a serious objection as during day time solar heat may be converted into mechanical energy and water may be pumped by means of this. For utilization of solar heat thin and flexible aluminium sheets known as 'Alcoa' are now used instead of glass. These metal sheets reflect only 80 per cent of solar radiation and can be used for years without dimming. The accumulated heat is protected by glass jackets enclosing high vacua like thermos bottles. By driving mechanically the heat collector in the direction of the sun's movement, the sun is followed in its daily march through the sky as also in the annual march from month to month. In clear sky condition one may expect to get from 1.2 to 1.4 calories per square centimetre per minute from the solar beam. But losses due to reflection and transmission from vacuum jacket leave 0.79 to 0.87 calories for use. Dr C. G. Abbot who is primarily responsible for sustained work in the mechanics of utilizing heat from the sun has published an exhaustive revised account of the various devices to which solar heat has been put in the *Smithsonian Miscellaneous Collections*, Vol. 98, No. 5 (reproduced in the *Publications of Astronomical Society of the Pacific*).

For domestic water heating, a shallow depression on the roof is lined with blackened sheet metal which

supports a blackened grid of pipes like steam radiator. The depression is generally covered with glass windows which focus the solar beam. Water circulates through the pipes and collects at a reservoir. Dr Abbot has been able to get 5 gallons of 'very hot water' in half an hour on sunny days.

He has developed cooking devices also. Engine cylinder oil within a blackened metal tube at the focus of the ray-collecting mirror was utilised as a heat conveyor to get temperatures which were obtained above the boiling point of water. About 60 gallons of this oil were employed for having a large capacity of heat. Two days of 7 hours' sunshine were required to initially heat the system. The heated oil is circulated by tubes to a sheath on the oven and the quantity of oil in the oven sheath guards against loss of temperature due to the temporary cloudiness and the night hours.

Solar heat has also been used to distil water. The entering water in the arrangement condenses steam and the temperature of the circulating water is gradually raised almost to boiling point, and only the latent heat of steam is supplied in the distilling device by solar radiation.

To overcome the interference by the clouds, Dr Abbot has made a 'solar flash boiler' which raises full steam pressure with 5 minutes of solar exposures. It is automatic so that water supply is stopped as soon as the sun is hidden by clouds, and more water is pumped when steam pressure rises above the desired maximum. By multiplying tubes connecting to the inlet and the outlet tubes leading to the boiler maximum amount of heat is obtained and the superheated steam is protected as well against cooling by the entering water. With the help of differential expansion between the boiler tube and an invar tape attached to the lower end of the boiler tube the temperature of the boiler gives an index to the prevailing steam pressure and controls the position of the carriage of the device. With the help of this difference of temperature, on the other hand, a uniformly rotating eccentric pin controls the pump of water. The efficiency factor of the flash boiler is 34.5 per cent; mechanical efficiency 75 per cent and efficiency of conversion of solar to mechanical energy 15.5 per cent. Dr Abbot suggests that with high efficiency and great simplicity of the present flash boiler scheme, power from the sun at not exceeding 0.5 per cent horse power/hour will be available, which is estimated to give a good return on the capital investment for building the device. Unless this heat energy from the sun is conserved there may not be any possibilities for its use in industrial organizations. Unfortunately, there is no thermal insulator as the electric insulators. It has however been suggested

that a silo-shaped cement-lined pit containing dry coarse sand, which is a very bad conductor, with a layer of glass wool on the top to protect against conduction and upward convection may serve as a storage agency. An appropriate network of pipes at the bottom and at the top of the sand pit (but not through the sand) will be connected to the solar heater. An automatic pump controlled by the heat of the focus tube will draw hot air into the top of the sand. The heat on the sand pile will gradually work down, the whole attaining the temperature of the focus tube on prolonged working. By reversing the circulation of the air, the heat of the sand would give the outgoing air from the top a very high temperature out of the heat of the sand pile.

Dr Abbot thinks that the best heat storage would be within a pressure tank filled with water with a thick coating of glass wool. The water, heated far above the boiling point, would supply steam for hours during cloudiness and night. He is of opinion that these solar devices being of extremely simple mechanism can be produced in mass scale at attractive prices, particularly for heating, cooking and distilling. He has estimated that New Mexico can supply ten trillion horse power-hours per year of mechanical power.

Beryllium and its Uses

BERYLLIUM is a metal which is hardly known to the public. There is no use of the metal separately in the pure state. Its property of increasing the hardness and resistivity of metals like copper, nickel, etc., even when present in a very small percentage, has made it commercially very important nowadays. The metal was identified in the year 1797. It was in the post-War period that the extraordinary heat-treatable characteristics of copper-beryllium alloys were discovered in Germany, which at once found a very high commercial application. It is lighter than aluminium, has a strong durability and fatigue resistance, and has strong affinity for oxygen.

Copper is a soft metal, but when 1.5 to 2.75 per cent of beryllium is added to it, after proper heat treatment, it acquires hardness comparable to that of steel. Usually 2 per cent is mixed, and the resultant alloy has a tensile strength of 70,000 pounds per sq. in. in an annealed soft state, whereas cold-rolled and heat treated strip will give a tensile strength of 190,000 lb. per sq. in. By way of contrast, structural steel has a tensile strength of 60,000 pounds. The peculiarity of this alloy is that it can be formed in relatively soft temper, and in the ductile state can be rolled, forged, and drawn.

After heat treatment it acquires its extreme strength and hardness. Beryllium-copper is non-magnetic and gives no spark when struck. It is very hard and wear-resistant, and is used for bearings and bushings and certain types of gears. Its non-sparking quality, coupled with hardness, makes it suitable for special tools to be used in plants where there are explosives or inflammable substances.

Beryllium-copper has a very wide use as a spring material. A more uniform product can be made, than is possible with spring steel or phosphor-bronze, and the alloy is virtually untiring. A beryllium-copper spring for example can be flexed 15 billion times as contrasted to 400,000 for phosphor-bronze.

Recently, cast moulds in plastics industry are being made of beryllium-copper alloy. It is particularly suitable for these moulds because it has a low melting point and good flowing qualities, which give excellent reproduction of intricate designs, and has a thermal conductivity twice that of steel, which permits a quicker moulding cycle.

When 2 per cent beryllium is added to nickel, the resultant alloy, after proper heat treatment, acquires a tensile strength of 260,000 lb. per sq. in. as contrasted to 60,000 lb. for structural steel and 90,000 lb. for stainless steel. Beryllium-nickel valve springs work in aircraft engines without showing the slightest fatigue and that bushings of this alloy has not yet failed for a single time.

Continuous attempts are being made to produce alloys of beryllium with aluminium and magnesium, but so far it has not yet been successful. If beryllium-aluminium alloys can be produced with the expected properties, then the aircraft industry will have a new material for engine pistons, and consequently the aircrafts will be much lighter.

Some of the interesting successes in beryllium research are nickel-chrome-iron-beryllium and beryllium gold. The former alloy has an elastic limit of 200,000 lb. per sq. in., is highly corrosion-resistant and non-magnetic. Its commercial use is now limited to replacing watch spring steel in high grade watches. Beryllium-gold formed with 1 per cent of beryllium is extremely hard and can be used as a dental inlay and for low-melting gold solders.

Beryllium has a very high affinity for oxygen and sulphur. The metal reacts with all oxides at high temperatures and combines very readily with sulphur. These deoxidising and desulphurising properties are now being used for the production of high conductivity copper castings and to remove the sulphur in the steel melts. Even when a high

sulphur content remains in steel, it is still possible to roll it, if beryllium is present in small amounts.

Side by side with the increasing use of beryllium its extraction processes has improved with consequent decrease in price. As recently as 1922 the cost was rupees 15,000 per pound. The present price is roughly Rs. 40/- to Rs. 45/- per pound.

N. K. S. G.

Industrial Research in the U. S. A.

FROM an analysis of the National Research council surveys it is found that the number of organisations in the U. S. A. maintaining research laboratories has grown from 900 in 1927 to more than 1700 in 1938. These afford employment to nearly 50,000 workers. The chemicals and allied products industries are engaging the largest number which was over 9,500 in 1938. Like the large factories of mass production where the progressing divisions of labour in manufacturing processes have made significant changes in the quality and quantity of production, the present-day research laboratories are systematically dividing complex problems among the specialists in the several sciences or their branches. Each works on a separate phase of the investigation and with the help of team work, the laboratories are achieving solution of various complicated industrial problems.

Manufacture of Liquid Gold in India

LIQUID gold is a dark, viscous oily substance containing organic compounds of gold and certain other suitable metals dissolved in essential oils. It is applied to the glass and ceramic articles to be decorated by means of a feather or a fine brush, either as such but usually after dilution with

essential oils. After drying, which usually takes about an hour, the articles are carefully fired in a muffle furnace in such a manner that the temperature rises gradually and uniformly. For this purpose, the use of a channel type of furnace in conjunction with a conveyer in which the suitable temperature gradients can easily be maintained is desirable. During firing, the organic portion of the liquid gold is lost, and a lustrous film of metallic gold which adheres firmly and cannot be easily removed is deposited on each article.

In liquid gold, the gold and the other necessary metals are present in the form of resins, which can be prepared either by interaction between the metal chloride and the sulphur-turpentine compound or by heating together the oxide of the metal with Venetian turpentine at the boiling point of the latter. The sulphur-turpentine compound is an oily dark brown liquid, prepared by heating flowers of sulphur with a mixture of Venetian turpentine and oil of turpentine.

That there should be no difficulty in manufacturing liquid gold in India, even during war time, and that the manufacture would be profitable, is suggested by the Industrial Research Bureau in their Bulletin No. 16 "*Manufacture and Application of Liquid Gold*" issued recently.

Used extensively by the Indian glass bangle industry and manufacturers of ceramic articles for decoration purposes, liquid gold has hitherto been exclusively imported from abroad. Since the outbreak of war, its supply has become greatly restricted and its price higher. The Industrial Research Bureau has estimated that to produce an ounce of liquid gold under war-time conditions would cost Rs. 16-7 instead of its peace-time cost of Rs. 13-3-10, or 24 per cent more.

Can Tidal Energy be Used in India for Production of Power ?

S. K. BANERJI

IN the rise and fall of the tide, we have an inexhaustible source of energy. In a very small way the energy of the tide has been utilised at various places. A tide mill in the river Tamar in England, which was installed in 1790, is reported to be still in operation. It is only recently that large-scale projects for harnessing the tides have been seriously proposed. The French Government have provided funds for

the construction of a tidal power station of an experimental type near Brest. In England consideration has been given to a tidal power scheme in the estuary of the Severn.

While the practicability of power production from tides is beyond question, the desirability and expediency of such a project will depend on the cost

at which power can be produced in any tidal power scheme. Norman Davey in his book entitled *Studies in Tidal Power* has classified the various schemes that have been suggested for the utilization of the tidal energy into four systems, (a) the float system, (b) the tidal stream system, (c) the compressed-air system, and (d) the basin system.

The Float System: The device is a very simple one. A floating body having considerable weight is lifted by the rising tide and during the fall of the tide this body is made to do work by means of a system of levers and gears. If an old ship, weighing 20,000 tons is made to work in this way over a tidal range of 20 feet and in a tidal cycle of $12\frac{1}{2}$ hours, its horse power is

$$\frac{2240 \times 20,000 \times 20}{12.5 \times 60 \times 33,000} = 36.2$$

Apart from the practical difficulties of working such a scheme, the relatively small power that can be obtained in this way makes it of little practical importance.

The Tidal Stream System: The tidal stream system makes use of paddle wheels, which are usually fixed on a raft anchored in a tidal river. The moving water, due to the tidal current, causes the paddle wheels to rotate. This system is more efficient than the float system, but, nevertheless, can be used only as small power units.

The Compressed-Air System: The compressed-air system makes use of the energy of the tides for the direct compression of air in closed chambers of suitable design. This system is more efficient than the two previous ones, but the cost involved in the design is so great that it is of very little practical value.

The Tidal Basin System: Of the various suggested schemes, the tidal basin system seems to offer the most practical method. There

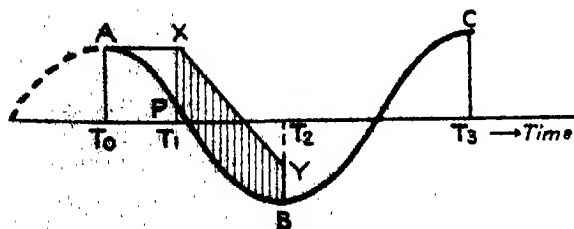


FIG. 1.

may be a single tidal basin cut off from the sea by a dam, in which are installed turbines, with intermittent periods of working and idleness, and equipped with suitable storage plant,

or a system of duplicate tidal basins capable of working at all stages of the tide and therefore without storage plant. If a single tidal basin is used, water may be allowed to enter the basin through sluices during the rising tide, and after the sea-level has fallen through a portion of its range, water is allowed to operate the turbines at a nearly constant head until low water.

If ABC (Fig. 1) represents the sea surface during a tidal cycle T_0T_3 , and if it is desired to work the turbines under the head PX, then the period of their working will be T_1T_2 and the period of idleness $T_0T_3 - T_1T_2$. It will be clear from the diagram that if it is proposed to increase the working head, the period of operation will be shortened. It can be easily shown that the maximum output will be obtained when the head is approximately half the tidal range.

We can get an increase in the output by utilizing both the rising and the falling tides. If we wish to do this, the arrangement of the water passages should be such as to permit the use of the turbines with a flow from either side of the wall in which they are set. Otherwise duplicate inflow turbines should be provided. With such an arrangement the work done in a tidal cycle would be about 50 per cent greater and the idle period of the turbines would be correspondingly shorter. The dimensions of the storage plant would also be reduced.

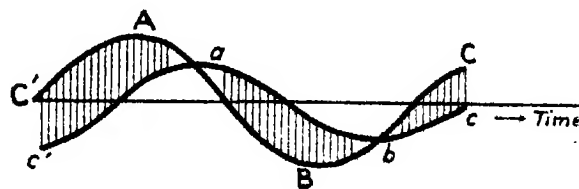


FIG. 2.

We can also arrange the system in such a way that the water during both the rising and falling tides flows through the turbines and adjusts its own level.

The working condition is illustrated in Fig. 2. Both the sea-level C'ABC and the level of water in the tidal basin, c'abc, undergo cyclical variation. The working head is shown by the shaded portion of the diagram. The head is variable and at the points, a, b, where the two curves intersect, it is zero. Therefore for an interval before and after these points, the turbines will stop working for want of sufficient working head. The working period and the possible output are greater with such an arrangement, but the variation of working head is a great disturbing factor.

If there are two tidal basins, namely "the upper basin" and "the lower basin", we can develop power almost continuously.

The working arrangement is illustrated diagrammatically in Fig. 3. Flow from the sea into the lower basin through the turbines occurs during the upper portion, C'AB', of the tidal rise. At the same time the upper basin is being filled through the sluices. During the lower portion of the tidal fall, B'D, flow through the turbines into the sea is allowed to take place from the upper basin. During this period the lower basin goes on emptying itself through its sluices. In this way the power is developed continuously; the output, however, is not appreciably greater than in the best of the single basin systems. The cost of providing two tidal basins and the duplicate sets of turbines makes the system lose much of its advantages.

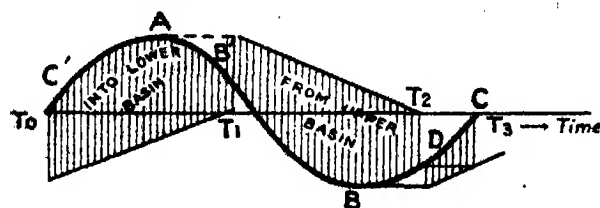


FIG. 3.

POWER AVAILABLE IN BASIN SYSTEMS

Let us suppose that at low water the sluices in a tidal basin having the area of A square miles, or 27,878,400 A square feet, are closed and remain closed during the entire period of the following rising tide. At the time of high water outside, there is a difference in head between the level of the water in the basin and the water outside equal to H feet. If the sluices be now opened, and if they be supposed to be large enough to permit the basin to be filled in a few minutes, a mass of water equal to 27,878,400 AH cubic feet will have entered the basin. Since the average distance of fall of the water is $\frac{1}{2}H$ feet and since the weight of a cubic foot of sea water is approximately 64 pounds, the amount of work which this mass of water is theoretically capable of doing is 892,108,800 AH^2 foot pounds. But this represents the work for the total tidal rise, or in a period of $6\frac{1}{4}$ hours. Hence the horse power theoretically available is

$$\frac{892,108,800AH^2}{6 \times 25 \times 60 \times 33,000} = 72AH^2.$$

The tidal power available therefore depends on two factors, namely, the area of the basin and the range of the tide; it varies directly as the area of the basin but as the square of the tidal range.

Therefore to get the best advantage we must construct the tidal basins at places where the tidal range is high.

SUITABLE PLACES IN INDIA FOR TIDAL BASINS

Because of the above consideration much attention has been given to the estuary of the Severn, the mean range of spring tides at Chepstow having the high value of 42 feet and of neap tides of 21 feet, as compared with the average value around the coast of Great Britain of 16.4 and 8.6 feet respectively.

For some of the Indian and Burma stations we get the following values from the tide-tables:—

Port.	Mean High Water Springs ft.	Mean High Water Neaps ft.
Akyab	7.85	5.58
Amherst	19.09	13.67
Bassein	8.62	7.22
Bey pore	4.16	3.49
Bhavnagar	34.30	27.27
Bombay (Apollo Bandar) ...	13.82	10.66
Chandbali	8.58	6.82
Chittagong	12.89	9.74
Coconada	4.99	3.71
Cochin	2.90	2.38
Colombo	2.21	1.43
Diamond Harbour (Hooghly River) ...	16.34	11.87
Dublat (Hooghly River) ...	16.28	12.06
Elephant Point (Rangoon River) ...	19.93	15.17
Karachi	8.74	6.82
Karwar	6.07	4.82
Kidderpore (Hooghly River) ...	15.80	12.84
Madras	3.49	2.57
Mergui	17.58	11.73
Marmagao	5.97	4.69

A tidal range of less than 10 feet is not of much practical value. The most suitable place for experimental tidal basins is Bhavnagar. If experiment is desired to be performed near a populous centre, then obviously the best place is the Hooghly River. If an area of 20 square miles could be utilised at the spring tidal range of Bhavnagar, the average output, working without storage plant, would approximate to a million horse power.

EFFECT OF FLUCTUATIONS IN HEAD

The principal difficulty in connection with any tidal power scheme lies in the relatively great fluctuations in head. The great relative differences between spring and neap tides present some difficulty.

It can be met by designing for the minimum head and thus utilising only a small proportion of the available energy, with a consequent increase of the power unit cost, or by adopting some equally costly form of storage reservoir, which could be used for the production of additional power in a secondary power plant during periods of neap tides.

This short note is intended to suggest the problem which offers a good deal of scope for inventive genius. Owing to the vast possibilities which await the development of tidal power it is most important that investigations at those places where conditions are most favourable should be pursued seriously.

Mineral Resources of Central Provinces and Berar

THE most important geological formations in the Central Provinces from the mineral point of view are the Dharwars, with their deposits of manganese ore, iron ore, steatite, red ochre and dolomite; the Gondwanas, with their stores of coal, fireclays and pottery-clays; the laterite, with its bauxite and building stone; and the alluvium with its supplies of brick-clays and kankar; while excellent building stones may be obtained from all the formations as well as materials for the manufacture of cement, particularly in the Lower Vindhya and Cuddapahs and there is the possibility of many minor mineral products being developed. This information is given in a paper on the Mineral Resources of the Central Provinces and Berar, published in the *Geological Survey of India Records*, Volume 74, part 3. The relative importance of the various mineral industries hitherto established in the province can be judged from the production figures for 1938:—

	Tons
Coal	1,658,626
Manganese Ore	646,465
Limestone and Kankar	551,978
Clay	60,252
Bauxite	4,634
Ochre	2,924
Steatite	2,189
Iron ore	611

COAL OUTPUT

The total coal available in the province is computed at 17,000 million tons of which the reserves of workable coal amount to 5,150 million tons. Of this nearly 4,000 million tons occur in the Wardha Valley, 1,000 million tons in Chhattisgarh Mahanadi and 150 million tons in Satpura region. A part of this reserve lies in Indian States. In spite, however,

of the existence of a large number of coal fields, the majority have not been worked partly because of their situation as regards communications and partly because of the rather inferior quality of coal. Coal worked in the Pench Valley fields which are the best producers in the province, is of average second grade and is now finding a good market in the Central Provinces, Gujerat and Bombay.

Judged from the standpoint either of quantity or of value, the manganese ore industry is the most important mineral industry of the province, which contains some of the finest manganese ore deposits in the world. Nearly 600,000 tons of the mineral are extracted every year. The rocks of the gondite series with which the manganese ores are associated are developed typically in the Chhindwara, Nagpur, Bhandara and Balaghat districts and to a small extent in Seoni.

VARIETY IN BUILDING MATERIAL

Materials suitable for building purposes occur in great variety and abundance. The alluvial tracts, not only of the Narbada, Purna, Wainganga, Kanhan and other big rivers, but also of many of the smaller streams, yield excellent brick-clays, whilst kankar is abundant in the tracts of older alluvium. Laterite is abundant in some parts while the Deccan trap provides an excellent building stone, and is also one of the best stones for macadam roads and for concrete-aggregate. The lameta or limestone occurring in the Satpuras and in Nagpur and Chanda (Karamgaon) constitutes an excellent ragstone.

There are several formations of excellent ornamental stones. For marble, the best known locality is the Marble Rocks in the Jubbulpore district, but numerous excellent marbles occur also in the Betul, Chhindwara, Nagpur, Seoni and Narsingpur district. Beautifully marked serpentine marbles can be had in Chhindwaras. Sandstones suitable for ashlar work and fine carving may be obtained from Bhutara hill

and Isapur in the Chanda district, Silewada near Kumptee, Akhund in Nimar and Ellichpur in Amraoti. Fine white sandstones are quarried at Sirgora and Pathe in Betul. The Panchmarhi sandstone is also a good building stone.

SANDSTONES

Red, yellow and buff sandstones used in so many of the famous buildings of Northern India have been taken from various divisions of the Upper Vindhya. The Rewah group near Hoshangabad has yielded thin red sandstone flags for use as roofing tiles. Limestone suitable for lime-burning and building purposes is found at Katni. Mixed with Lower Vindhyan shales it is also used for the manufacture of cement, while the Raipur and Penganga limestones are now being extensively used for building purposes. A pure quartzite suitable for crushing for glass sand occurs in large masses near Kishanpur, ten miles from Narsinghpur railway station.

White clays are often seen in the Jabalpur beds of Jabulpore and Chhindwara district. The Jabulpore potteries obtain their supplies from near the town. In Chhindwara the clay beds are 2 to 3 ft. thick and sometimes as much as 10 ft. white clay is also available in Drug district. Fire clay is often found in the Indian coal measures, associated with coal-seams, frequently as an under-clay, and could probably be obtained from most of the coalfields of the Central Provinces if required. Upper Gondwana clays of Jabulpore are found to be exceedingly refractory and are used in pottery works.

ALUMINIUM ORE

Large quantities of aluminium ore occur in Baihar plateau in the Balaghat district and near Katni in the Jabulpore district. Mandla and Seoni districts, too, have some good deposits. In recent years some deposits with 60 per cent of alumina have been found to occur near Bhabei and further south in Nandgaon State.

Both red and yellow ochres occur at several localities in the province. Red ochre is mined at Jauli in the Jabulpore district and is also available in the Gandai and in the Salitekri hills in the Balaghat district. Small lenses of earthy haematite

which should prove useful as a paint material are found between the Sukkur river and the Narsinghpur-Chhindwara road. Steatite is reported from several localities, the best known of which is the Marble Rocks near Jabulpore. There are also deposits at Gowari and Lalpur to the south of the Nerbada and near Rupaund on the Katni-Bilaspur branch of the Bengal Nagpur Railway. Pot-stone and steatitic schist have been reported from several localities in the Bhandara district, whilst at Jambal Ghat in the crystalline area of Chanda is a dark-coloured pot-stone formerly used for carving into idols and household vessels. Similar rock from near Kilokora in the Drug district is also worked for making utensils. Soapstone has also been reported from near Wun.

IRON ORES

The most valuable and abundant of the Central Provinces iron ores occur in the Dharwarian rocks, particularly in the Chanda and Drug districts and in Bastar State. At least ten separate deposits, some of which are of large size, have been located in the Chanda district. The most striking occurrence in the Drug district is the ridge which includes the Dhalli and Rajhara hills, extending for some 20 miles in a zig-zag, almost continuous line, and rising to a height of some 400 feet above the general level of the flat country around. In the Rajhara hills there exists $2\frac{1}{2}$ million tons of ore carrying about 67.5 per cent of iron. The reserves of ore in the Bastar State are estimated to be 114 and 610 million tons, and the ore is of excellent quality. Though occurrence of mica, quartzite, copper, lead, silver, feldspar, wolfram varieties are also reported, the discoveries have not hitherto proved to be of much value.

SALT RESOURCES

There are four hot springs in the province. The crater lake near the village of Lonar, in the Buldana district, Berar, contains a large proportion of carbonate of soda which crystallises out on the evaporation of the lake during the hot season and is used in the manufacture of glass and soap. A certain quantity of salt is also obtained as a by-product in the manufacture of carbonate of soda from the brine of the Lonar lake. A deposit of saliferous sand or clayey sandstone has also been noted beneath the alluvial deposits of Western Chanda.

MEDICINE & PUBLIC HEALTH

New Syphilis Cure

A NEW method of curing syphilis has been reported from the Manhattan Mount Sinai Hospital in eastern U. S. From the bottom of a glass jar suspended above a syphilitic patient's bed a yellowish fluid trickles through a flexible glass tube into a needle inserted in the vein between his elbow and wrist. The apparatus is an ordinary "Murphy drip," long used for glucose feedings. In the jar is a sugar solution of mapharsen, one of the earlier of the 950-odd arsenic compounds invented by Paul Ehrlich, and the drug seeped two drops every three seconds into the patient's veins. With the drip method, early syphilis is expected to be cured in five days.

The slow dripping of mapharsen into the bloodstream of the patient for eight hours a day eliminates the "shock" of relatively large injections, builds up blood tolerance to huge concentrations of the essential arsenic. During a five-day treatment, a patient absorbs about two and a half gallons of mapharsen solution.

The doctors first tried neoarsphenamine in their Murphy drip, but found it "too dangerous." Mapharsen, which is less toxic, was discarded by Ehrlich because it was too unstable. But modern chemists have "set" the drug. The entire course costs only \$82 a patient, as contrasted with an average of \$300 for the standard 18 months of arsphenamine injections. There is however a drawback to mass cures in this technique as it can be used only in hospitals, not in doctor's chambers.

Grass for Health

When Nebuchadnezzar, the Babylonian king, was feeling low, he crawled on his hands and knees and ate grass. But Nebuchadnezzar also drove the Egyptians out of Asia, conquered Syria, destroyed Jerusalem. After four years of analysis and experiment, *Time* reports that it has been proved that grain grass contains all the vitamins except D, has 28 times more vitamins per pound than dried fruits or vegetables. It has 23 times more vitamin A than carrots;

nine times more vitamin B₁ than leafy green vegetables; 22 times more vitamin B₂ than lettuce; 14 times more vitamin C than tomatoes and citrus fruits.

The scientists ate this grass, in a form made fit for consumption by mixing it with other food-stuff, all winter, caught no colds, and enjoyed excellent health. Three U. S. factories and one Canadian are now making powdered grass. The approximate cost is 6 cents per lb. It was reported to the American Chemical Society meeting in Cincinnati in April last that the use of only twelve pounds of powdered grass a year would supply the necessary factors for a liberal diet to all U. S. families at a price they could afford for the first time in history.

Doctors have already begun to feed powdered grass solution to new-born infants with haemorrhages. Of the 20-odd vitamins known to science, about ten can be extracted from plants or produced artificially. Most important vitamins on the physician's shelf are

- (i) Vitamin A: for night blindness and certain skin diseases.
- (ii) Vitamin B complex (consisting of some 15 related vitamins): for pellagra, and for deafness caused by deterioration of the auditory nerve.
- (iii) Vitamin B₁ (thiamin): for beriberi, anorexia, certain heart disturbances, inadequate lactation, nerve diseases of alcoholism, facial neuralgia, cirrhosis of the liver, sciatica.
- (iv) Vitamin B₂ (riboflavin): for blindness caused by inflammation of the cornea, certain skin disorders.
- (v) Vitamin C (ascorbic acid): for scurvy, pyorrhoea, rheumatic fever, wound healing, haemorrhage, cataract, insomnia, inflammation of bone marrow.
- (vi) Vitamin D (calciferol): for rickets, nervous spasms, softening of the bones, acne, psoriasis.

(vii) Vitamin E (alpha-tocopherol) : for sterility, muscle weakness, diseases caused by degeneration of nerves.

(viii) Vitamin K : for haemorrhage.

Drug Difficulty in India

In the economy of drugs, due to the present difficulty of supply, medical men should avoid noncritical and indiscriminate use of drugs and too much drugging. They should further avoid proprietary medicines whose potency and usefulness in Indian market at least cannot be guaranteed. To tide over the anticipated shortage of drugs Dr B. Mukerji of the Biochemical Standardization Laboratory in the course of a lecture delivered at Burdwan Medical School suggested the use of 'substitutes' or 'equivalents' for preparations which have already become scarce or which are considered necessary to conserve against the eventuality of their supplies being completely cut off. Synthetic remedies and organo-metallic products like Veronal, Medinal, Luminal, Adalin, Novalgin, Veramon, Eukodal, Phenacetin, Pyramidon, Resorcin, Omnadin, Hexamine, Yatren, Solustibosan, Neo-stibosan, Neo-salvarsan, Progynon, Protulon, Prontosil, Campolon, Atebrin, Plasmoguin, Protargol, etc., will not be available for some time to come. It is understood that attempts are being made to procure from neutral countries at least one of the two 'long-acting' barbituric acid derivatives and another member of the 'short-acting' barbiturate class like 'amytal', and practitioners will be well advised to stick to them whenever required in preference to other similar German preparations like Evipan, or Evipan-sodium. Surgeons will have to concentrate on the use of general anaesthetics like sulphuric ether and chloroform. Ethyl chloride, nitrous oxide, vinyl ether, cyclopropane, etc., may not be available at all after some time. In the group of local anaesthetics, it will perhaps be found advisable to call for only the standard ones like procaine, orthocaine and benzocaine rather than prescribe pantocaine or percaine. Though 'Prontosil' will be largely missed by practitioners, equivalent or perhaps more potent derivatives of the same type may soon be manufactured in England and Indian supplies of 'sulphonamides' should in all probability be maintained. 'Myosalvarsan' and 'Neo-salvarsan' will be scarce but equivalent preparations of British and American make will be procurable. In place of Protargol, a preparation of silver proteinate of British manufacture is available. A local firm (Bengal Chemical) has also produced one which seems to be almost identical in laboratory tests. 'Atebrin' and 'Plasmoguin' will have to be forgotten

for some time until their manufacture on a commercial scale is achieved in India. Injectable liver extracts have been put out by local firms and these must supplant 'Campolon' for some time to come.

Regarding the vegetable drug resources of India and her other potential chemical resources, Dr Mukerji thought it curious that India, the house of medicinal herbs and drugs, should remain dependent to such an extent on foreign imports. Nature has been particularly bountiful to her in this regard as will be evident from the fact that nearly three fourths of the drugs mentioned in the British and other pharmacopoeias grow here in a state of nature and the remaining one fourth can be easily cultivated. Where pharmacopoeial species do not grow, allied species are available which may be used as substitutes.

The Association of British Chemical Manufacturers has already published a list of British 'substitutes' or 'equivalents' of foreign pharmaceutical preparations for which a likely shortage exists. This list has been reproduced in the *British Medical Journal* and in the *Journal of the Indian Medical Association*. A similar list with Indian equivalents is in the course of preparation in the Biochemical Standardization Laboratory.

It should, however, be emphasised that this can only be treated as a temporary measure. Our efforts should be concentrated on the manufacture of all these products in India, for which our resources are ample and scientific talents are available.

Loss of Vitamin B₁ from Rice

NUTRITION researches under Dr W. R. Aykroyd at Coonoor have shown that Vitamin B₁ is progressively lost with each polishing of rice. If however the rice is previously parboiled, resulting thereby in a diffusion of vitamin B₁ from the germ and pericarp into the grain, subsequent milling causes only slight loss. Therefore when the staple food is raw milled rice, beri-beri is more likely to occur than with a staple food of parboiled milled rice. Many food factors in rice being soluble in water are readily lost on washing and cooking if the cooking water is discarded. The losses are of the following order—calories—15% ; protein—10% ; iron—75% ; calcium and phosphorus—50% ; vitamin B₁ and nicotinic acid—40 to 50%. Working with milled parboiled rice in Bengal, Dr S. Banerjee (*SCIENCE AND CULTURE*, 5: 262, 1939) has shown that in the usual cooking process in which the water after boiling is discarded, rice suffers the following losses—protein 3.7% ; iron 47% ; calcium 78% ; phosphorus 18%. Considering that the ordinary diet in India is deficient in many

respects, it would seem advisable that the water used in cooking rice should not be discarded.

P. K. C.

Vitamin C and Toxins

OBSERVATIONS by B. Ghosh (*J. Ind. Chem. Soc.*, 16, 241, 1939) on the effect of diphtheria toxins on the ascorbic acid contents of blood and various

organs and on its excretion in the urine at the University College of Science and Technology, Calcutta, showed a decrease of ascorbic acid content most marked in the adrenal glands. The ascorbic excretion in urine showed a decrease in the free acid and an increase in the combined acid. These observations support the view that vitamin C is of major importance in the detoxicating process.

P. K. C.

Physics in Aid of Medicine *

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AND

P. K. SEN CHAUDHURY

PHYSICAL APPARATUS IN USE BY MEDICAL MEN

MEDICINE, the science of healing, has to lay almost all the basic sciences under contribution, and the prevailing impression is that the lion's share is monopolised by chemistry. But if an impartial jury were today set up, to adjudicate between the claims of chemistry and physics, the chance is nearly 50:50 that they will find in favour of physics. Physics has given medical men instruments, apparatus and appliances which are almost in daily use by the general practitioner. One need mention only the thermometer, the stethoscope, the ophthalmoscope, and the sphygmomanometer. But experts today, both in medicine proper and in subjects connected with medical research, use a vast number of physical apparatus and appliances about which the average man has hardly any idea. One need mention only the use of X-rays by surgeons, of radium for the cure of cancer and skin diseases. Another physical instrument, the spectroscope, has been found very useful in vitamin chemistry and recently with its aid, the important discovery has been made that deficiency of certain minerals which occur in our foodstuff in minute proportions may give rise to many diseases and ailments, the origin of which has been so long obscure, amongst men and beasts.

* Based on a public lecture delivered by Professor Saha at the Royal Asiatic Society of Bengal.

The lecturer visited some four years ago the International Congress of Physical Medicine which was held in London in 1936 and was attended by delegates from almost all the countries of the world. There he realised for the first time the great part which physics was destined to play in the near future in the art and profession of healing. Later he attended the Harvard Tercentenary where Prof. Krogh of the University of Copenhagen gave a lecture on the use of isotopes as indicators in biological research. Last year the Rockefeller Foundation of New York devoted a large part of its Report to the description of the cyclotron, the latest physical apparatus used for "Nucleus-busting" and the development of the science of molecular biology, which makes use of recent advances in the physics of the nucleus of the atom. All these indicate the growing importance attached by medical men to the recent discoveries in physics and their eagerness to utilise them for medical research.

PHYSICAL IDEAS IN MEDICAL RESEARCH

When one goes into the working of these methods, it is very difficult for a scientist to obtain any intellectual satisfaction. The position is very well expressed by an acute observer. "The medical man uses physical apparatus just to enhance his clinical sense, but has not yet learnt to use physical ideas for understanding the human body and its

ailments. As an example of this attitude, we can take the case of radium which has been used for the treatment of cancer and many other diseases from the time when Becquerel and Pierre Curie discovered that bottles containing small quantities of radium, which they used to carry in their pockets, produced burns in their skin. But in spite of 40 years of work on the use of radium on the human body it is rather surprising to read the following remarks in the introduction to a well-known monograph on Radium and Cancer.

"Moreover, after years of labour and of the most painstaking research there is no general agreement* on the best methods of application or even as to the period over which the treatment should extend. London regards as inadequate a period under 14 days, Stockholm is satisfied that a period of four hours is ample, whilst America, as might perhaps be expected, uses a stop watch. And yet all claim, so far as we can see, to obtain very similar results."

Perhaps part of the confusion arises from the fact that in radium, surgeons are using a tool the action of which they can scarcely be expected to understand since it involves a knowledge of physics which they cannot reasonably be expected to possess, whilst on the other hand, the physicists cannot possibly grasp all the difficult clinical and biological problems which confront these surgeons. The lecturer was further surprised to read in this book that even after 40 years of work the ways in which the different rays from radium—alpha, beta and gamma,—work upon the cells are not definitely known. It proves that in the attack on human disease and on biological problems by medical men where physical methods are going to be applied the need of co-operation by competent physicists is necessary, and without that intelligent co-operation many of the results are likely to prove spurious.

If this be the position in European countries, one can easily understand the lack of system which exists in this country. It is reported that a scheme is pending before the Government of Bengal for the Medical College Hospital at Calcutta for large-scale use of radium. A similar scheme is in operation at the Tata Memorial Cancer Hospital at Bombay. We are not aware whether sponsors of these schemes have in view the employment of trained research physicists. At present there is hardly any medical

college or a first-rate hospital which employs physicists well-versed in research work, or conversant with the latest developments in physics. Their place cannot be taken by those who are employed for giving elementary lessons in physics to fresh students of medicine or to act as technical assistants to medical men in the manipulation of physical apparatus. Even some of the hospitals in this country possessing large amounts of radium (one hospital possesses as much as 1600 milligrams), and X-ray apparatus for deep therapy hardly employ physicists with research experience for a systematic well-planned attack with their appliances on tropical diseases. In this connection, attention may be drawn to a letter which Prof. D. M. Bose, now Director of the Bose Research Institute, and the senior writer wrote to the press when, four years ago, the Calcutta Medical College celebrated its centenary, and purchased, out of the subscription raised on the occasion, 250 milligrams of radium to which a further lot of 50 milligrams has since been added. We pointed out that the radium, instead of being kept in small amounts in tubes of glass or metals, may be at least partly kept in the form of a solution, from which radon tubes (seeds) may be prepared by a trained physicist regularly, and distributed for a small payment to general medical practitioners. This is the custom in most radium hospitals in Europe, and the other day it was given out that the Dublin Radium Hospital distributed in course of a year about 11000 radon tubes amongst the general practitioners in Ireland. This practice has got great advantages; the original amount of radium remains intact, and absolutely safe under lock and key. The radon tubes are quite as good as the original radium so far as curative properties are concerned, for about a week. It becomes possible for the practitioner who has no connection with the hospital, and who cannot afford the luxury of having his own store of radium, to use radium rays on his patients, whilst under the present system, the use of radium is confined only to medical men who are directly connected with the hospital, and to patients who can afford to come to the hospital. The adoption of the measure advocated by us will bring the benefits of radium treatment to a far wider circle of patients, and though it involves the employment of a trained physicist, the cost is justified on humanitarian as well as utilitarian grounds, and it is hoped that the authorities of the two medical colleges at Calcutta will see their way in giving effect to our suggestions.

* It has been reported that dosage has been worked out very accurately on physical principles and that Stockholm uses the shorter periods in order to be able to treat a larger number of patients. What is aimed at now in the case of malignant disease is to get a uniform distribution of radiation and in the case of carcinomata to try and get a dose of something like 9000 r. units at the centre of the tumour mass.

As a further example of the way in which medicine may derive benefit by the employment of trained physicists, I may refer to shortwaves having wavelengths between 3 to 30 metres now being used for local heating of the tissues. While reading a medical report on short wave therapy, I was amazed

at the amount of contradictions in the results reported by well-known medical authorities. Some claim that these waves have a selective action on certain tissues and others entirely deny that, but there seems to be general agreement that by means of shortwaves, the temperature of parts of the body can be locally raised and many cures can be effected. Here also co-operation of physicists who are well-trained in the manipulation of short waves with a biologist is bound to lead to very fruitful results.

HUMAN BODY AS A PIECE OF PHYSICAL APPARATUS

In an assembly of medical men, one has to be cautious in his expressions, but the lecturer has hopes that the study of the human body as a piece of physical apparatus is likely to lead to great and fruitful results. By the application of well-known principles of physics, many operations hitherto considered impossible by surgeons, have been successfully tackled. One may mention the discovery of the artificial heart, an elaborate piece of physical machinery, which can take over the function of the heart for a short time, thus enabling the surgeon to perform operations on that delicate organ which, a few years ago, were considered impossible. It is reported that Dr Gibbon has invented an artificial heart, which can pump blood from the jugular vein and thus temporarily take over the functions of the heart. Operations were performed a year ago on the hearts of six cats, while they were kept alive during the time of operation by the artificial heart. Of the six cats so operated, all are alive and healthy, and one has brought out a litter of six kittens. The invention of the artificial lungs has rendered operations on the lungs possible, and has opened a way for a successful attack on pulmonary diseases. Of great interest is the discovery of the Perfusion Pump by Carrel and Lindbergh, which enables a piece of tissue to be maintained in suitable atmosphere, fed automatically and thus kept alive for an indefinite period. The discovery of the Perfusion Pump was possible because there was co-operation between a man well-versed in mechanical engineering and another who is the great pioneer of tissue culture.

EMPIRICAL NATURE OF MEDICAL RESEARCH

In recent years, we have heard much about the cyclotron, the wonderful machine that has rendered the alchemists' dream of transmuting one element to another a practical reality. But it is not so well known that this apparatus has opened a great future for biological and medical research, and it was stated in a recent symposium on biophysics that the time is possibly near when a cyclotron manufacturing 'radioactive atom' will be as

familiar a feature of first class medical colleges and hospitals as an X-ray machine is at the present moment. Let us see what the new machine means for the medical men and the biologist.

Even medical men will admit that the action of drugs on the human system is yet far from being clearly understood. The successful practitioner has mostly to depend on his sixth sense, when he prescribes a medicine for a certain ailment.

The position has much improved since the great pioneer Ehrlich showed that bacteria of certain diseases can be successfully tackled by properly designed molecules. One can refer to his epoch-making work, whereby the foul disease of syphilis was successfully combated by the use of Salvarsan, discovered after 606 trials. Since his times, his example has been emulated in many countries, not excluding ours. Here Sir U. N. Brahmachari found after hundreds of unsuccessful experiments, that the kala-azar parasite (Leishmann-Donovan bodies) can be successfully combated by the application of antimony in the form of Urea Stibamine, a discovery which has led to the conquest of kala-azar, and has saved millions of lives in this country.

But a far large number of unsuccessful investigations shows that the specific action of drugs on the human system and the way in which they lead to the cure of drugs is mostly a "terra incognita", and even the combination of chemistry and bacteriology has not given us a royal road. If success crowns any investigator's efforts, it is as much due to his doggedness as to luck, or some brain wave. For example, in spite of thousands of attempts, an infallible remedy against malarial fever in all its stages, like Urea Stibamine against Kala-azar, has not yet been found.

What is the reason for this state of affairs? The difficulty can be appreciated if we try to approach the problem from the physicists' point of view. A gm. molecule of matter contains about a quadrillion molecules (6 followed by 23 zeros); when even the smallest dose of a medicine is administered to the human body, say a milligram of quinine we add to the human system about 2 trillion molecules (2 followed 18 zeros), they get distributed throughout the whole system, sometimes preferring certain regions and avoiding others. It becomes almost an impossible task to track how the molecules have distributed themselves in the different parts of the system, what reactions they are producing there, and which of these reactions in particular is responsible for the cure of the disease. The position can be rendered clear by an analogy: suppose we take the Ganges river, and release near its source a ton of sand particles and we ask the hydraulic engineer

to find out how these sand particles have distributed themselves in the main stream, in the branches, and tributaries, and in the estuaries. Can he do it? The answer will be a decided "No", because a fair-sized river from its sources to the mouth contains about 10^{15} c.c. of water, and one ton contains about 10^9 sand particles, hence there will be barely one particle in 100 liters of water, and this will mix up with host of other sand particles from which it is undistinguishable. But suppose we find out a way of giving the original sand particles a label—a hall-mark, by which it can be easily identified even when it is mixed up with hundreds of thousands of common sand-particles. Then the task will no longer appear impossible. The prospector has only to look for the "labelled sand particles" in any sample of water which he fishes out. This is exactly what the cyclotron and newer technique in physics promises to achieve. The ordinary atoms of which a drug is composed cannot be distinguished from its fellow-atoms of the same variety. But the cyclotron can impress upon atoms "a hall-mark", which does not interfere with its ordinary chemical or physical properties, but by means of this 'hall-mark', the particular atom, tagged atom as it is called, can be distinguished from the myriads of its fellow-atoms, and the method is so sensitive that even single atoms can be detected.

HOW A HALL-MARK IS IMPARTED ON INDIVIDUAL ATOMS

To understand how this 'hall-mark' is imparted to atoms and how they can be individually detected, let us make a little digression into atomic physics. You must be aware that the atom was split up nearly forty-four years ago. It is now known that the atom consists of two broad parts; the nucleus or the heart of the atom, and the outer shell of electrons. When we take an element like copper which is the twentieth element in the periodic table, we can take it that it has a 'nucleus' or heart which has a positive charge of 29 and nearly all the 'mass' of the atom which is 63 in this case. It is surrounded by 29 electrons. Now, it has been proved that all the chemical and physical properties are caused by the action of the outer shell of electrons. They give to the copper atom its valency of one or two, enabling it to form CuCl or CuCl_2 , etc. The outer shell of electrons, when excited by bombardment with electrons of sufficient energy from an outside source, give us the characteristic green light of copper or better the ultra-violet light by which it can be identified. The chemical and physical reactions which we attribute to an atom are all due to the activity of the outermost electrons. But the innermost electrons can also be dislodged; then the atom

gives its characteristic X-rays which are used by the surgeon, or the X-ray therapist.

In all these reactions, the nucleus takes no direct part, and none of these reactions can be detected unless we handle nearly 10^{15} atoms. For example, if we want to find out whether there is sufficient amount of iodine in some part of the human body, say the thyroid gland, we have to take a quantity of tissues weighing about 20 to 25 gms; for the least number of iodine atoms which can be detected either by its spectrum or by the sensitive starch reaction is at least 10^{15} to 10^{17} , and thyroid gland issues contain only 2 per cent of iodine. How much it would mean for the progress of medical research, if some method could be discovered by which a concentration of 10^5 or 10^6 atoms of iodine in some part of the human system could be detected? The method will be 10^6 times more sensitive than any existing chemical or spectroscopic method.

We now turn to the 'nucleus' of the atom. It is not quite correct that the 'nucleus' is entirely indifferent to the electrons in action. Though it takes no direct part, it indirectly controls all their activity. The part it plays may be made clear by an analogy. It may be a matter of experience to you that if you wish to get anything done by a political party, it is no use trying to convert the rank and file to your views. You have to try to change the heart of the 'Boss' who controls the party machinery and convert him to your views. If you succeed in doing that, the rank and file and the rabble will automatically range themselves on your side. Need we say, that the changed behaviour of the rank and file will be to the invisible influence of the 'Boss'.

The atom is, in many respects, like a well-organised political party machinery. If you want the mercury atom to behave like gold as the older alchemists wanted to do, it is no good trying any physical or chemical method, *i.e.*, trying merely to influence the external electrons, or following our analogy, the rank and file of the party. They will not listen to you unless you strike at the 'heart' or the nucleus of the atom and try to persuade "him" to behave in a different way. But a few years back, however, we saw no way of achieving this ideal.

This is because the nucleus, like the political boss, is a highly strong personage and it resents any attempt on the part of the 'rank and file' coming near it. The electron also has an inexplicable shyness for the nucleus. No amount of cajoling on the part of the physicist has been able to persuade it to enter the nucleus. If we wish to convert the nucleus, we must send to it a fundamental particle of its own caste, *e.g.*, a proton, which is the nucleus of the lightest element hydrogen, or an alpha particle which is the

nucleus of the second element helium, or better still, a neutron, a new fundamental particle which has no charge or the deuteron which is the nucleus of heavy hydrogen. The charged particles must be provided with enormous energy, otherwise they will be turned back before they can reach within a striking distance of the nucleus. This energy is of the order of a million volts.

It need hardly be added that the energies of all chemical and physical reactions can now be rated in terms of the electrical unit of energy. This is the electron volt, *i.e.*, the energy of an electron when it falls through a potential difference of one volt. When we excite a copper atom to emit its peacock green light, we impart to the outermost electron an energy of about 5 volts. When copper forms a union with chlorine atom, a somewhat smaller amount of energy is liberated.

When a medical man uses X-rays from copper, he is probably not conscious that he is using very high-energy particles. These are the electrons which are allowed to fall through a potential difference of about ten thousand volts. When such high-energy electrons strike a target, *i.e.*, the anticathode, their energy is converted to X-rays, which can pass through the human body, and expose to the surgeon's view any foreign matter embedded inside the body. Here the radiologist should be reminded of his indebtedness to the physicist. If the latter did not bring out a fool-proof hundred thousand volt generator, no X-rays could have been produced.

But even the energy required to produce X-rays is insignificant compared to that required to produce

nuclear reactions. We must have a generator capable of producing several million volts, and should be able to make the positively charged particle fall through this huge potential, and thus endow it with the energy which will enable it to approach the nucleus. Once contact with the nucleus is established, we get a new nucleus—we have effected 'Transmutation of Elements'.

This brings you face to face with the difficulties of the task. A million volt generator will give a spark of tens of feet, and is most unsafe to work with. We must have specially designed rooms, and arrangements to handle it. After ten years of work, a number of such apparatus has been produced and used for 'Nucleus-busting' as the Americans say, such is the Van de Graff Generator which is merely the old Wimhurst machine in a new guise. A modification of it, the Herb Generator, has been used to produce half million volt X-rays. The second is the Cascade Generator, which was used by the late Lord Rutherford and his school in their pioneer work on "Nucleus-busting". By consensus of opinion, the cyclotron*, an invention of Prof. E. O. Lawrence of the University of California, is the most powerful of such apparatus, though others have their own advantages. It can give us about 25 million volt protons. Armed with these particles, we can bombard any nucleus, and watch what happens to it.

To be continued.

* An account of the working of the cyclotron was published in this journal in the issue of January, 1940, pp. 403-9.

LOCUSTS AS PAYING PESTS

THE cost of fighting the locust pest is tremendous and the damage still done is immense, but since it was found that locust oil—owing to its capacity for remaining liquid at very low temperatures—is of great value for aeroplane engines, a means has suggested itself of transforming an apparently inevitable plague into a form of profit. In Johannesburg some years ago a factory was established for the conversion of dead locusts into fertiliser; and as food for cattle and poultry, consignments of the insects have been shipped abroad.

It is not too far-fetched to picture locusts as contributing towards the future prosperity of nations, especially as investigation has already led to many and interesting discoveries regarding the habits of these pests. For instance, the direction of the wind definitely influences their flight, and it has been proved that once they fly off, they do not return to the scene of their departure. Some, however, always remain at the original site—a fact which has facilitated the tracking of various gathering grounds near the Red Sea and in some of the desert regions of India.

Eggs are laid in the sand, and it is apparently during years of heavy winter rainfall that they hatch out in vast numbers. For about two months they have no wings—a factor taken into consideration in measures for destruction and they feed on desert plants until they are ready to fly.

—The Statesman.

Research Notes

Scattering of Light by Binary Liquid Mixtures

It was first reported by R. S. Krishnan (*Proc. Ind. Acad. Sci.*, 1, 211, 1934) that the light scattered by some binary liquid mixtures, e.g., carbon-disulphide, methyl alcohol, water-isobutyric acid etc., at the respective critical solution temperatures, the value of ρ_h is greater than unity, where ρ_h is the factor of depolarisation of light scattered in the direction parallel to the electric vector of the incident plane polarised parallel beam of light. Comparing these experimental results with those of the theoretical investigations on the scattering of light by large particles put forward previously by Lord Rayleigh (*Scientific Papers*, 5, 547), Mie (*Ann. de Phys.*, 35, 377, 1908) and Shulejkin (*Phil. Mag.*, 48, 307, 1924), Krishnan drew the conclusion that large clusters of molecules are formed in the mixtures at and in the neighbourhood of the critical solution temperature. The phenomenon mentioned above was called the 'Krishnan effect' by Gans (*Phys. Zeit.*, 37, 917, 1936), who put forward a theory to explain the anomalous values of ρ_h by assuming the formation of large clusters of molecules in the mixtures. Vrkljan and Katalinic (*Phys. Zeit.*, 37, 482, 1936) also made some theoretical investigations on the relation between values of ρ_h and the size and shape of the clusters. Later on, Hans Mueller (*Proc. Roy. Soc., A*, 166, 425, 1938) put forward a new theory of light scattering based on the experimental results of Krishnan. Recently a paper entitled "On The Theory of Light Scattering" by S. Parthasarathy has appeared (*Phil. Mag.*, 29, 148, 1940) in which the author has pointed out that values of ρ_h greater than unity are obtained in some cases if the incident light be slightly convergent instead of being strictly parallel. He has also shown that the results obtained by Krishnan in the case of a few binary liquid mixtures can be explained by the ordinary theory of scattering of light by pure liquids if the convergence of incident light actually obtaining in the experimental arrangements made by Krishnan is taken into account. He has thus pointed out that the results obtained by Krishnan do not exhibit any new phenomenon but they actually show how anomalous values of ρ_h are obtained if the incident light be not

strictly parallel. He has thus shown that Krishnan's hypothesis that clusters of molecules are formed in binary liquid mixtures at critical solution temperatures is not correct.

S. C. S.

The B Vitamins and Fat Metabolism

BENDER and Supplee (*J. Am. Chem. Soc.*, 59, 1178, 1937) saw that rice polishing concentrate had a supplemental effect upon body weight. They correlated the weight changes with the presence and absence of dermatitis, interpreting their results to mean that the factor in rice polishing concentrate affecting growth was vitamin B₆. McHenry (*J. Physiol.*, 89, 287, 1937) saw that high fat diet free from choline and supplemented with thiamine caused a great increase in liver fat. In a study of vitamin B₆ deficiency in rats, Halliday (*J. Nutrition*, 16, 285, 1937) found significantly heavier livers containing a higher percentage of total fatty acids in different animals. The addition of choline remedied this condition to a large extent but even massive doses failed to bring the liver weight and total fatty acid content quite to normal. McHenry and Gavin (*J. Biol. Chem.*, 125, 653, 1938) showed that rice polishing concentrate used as a dietary supplement in conjunction with thiamine and riboflavin caused an appreciable increase in the body fats of rats. In order to determine which factor of the vitamin B-complex is responsible to influence the weight and body fat in rats Gavin and McHenry (*J. Biol. Chem.*, 132, 41, 1940) recently made an elaborate study of the fact and have shown that (a) when thiamine was the only supplement, a body could synthesise fat from carbohydrate; (b) the administration of vitamin B₆ in conjunction with thiamine, riboflavin and choline to rats fed a fat-free diet caused a slight increase in body fat and an increase in body weight; (c) nicotinic acid slightly augments the effect of vitamin B₆ upon body fat but not upon body weight. Neither vitamin B₆, nicotinic acid nor riboflavin could prevent the deposition of fat in the liver

which results when thiamine was administered. The amount of liver fat was normal when choline was supplemented either alone or with any combination of the above facts. They could not get any satisfactory explanation of Halliday's experiment. Recently Hastings *et al* (*J. Biol. Chem.*, 129, 295, 1939) noted a decrease in liver metabolism associated with fatty infiltration when rats were kept on a basal diet without added yeast extract. After the administration of yeast extract, neither effect was evident. György and Goldblatt (*J. Exp. Med.* 70, 185, 1939) reported liver injury occurring in some rats kept on a diet deficient in the vitamin B-complex and supplemented with thiamine, riboflavin and purified vitamin B₆ preparation.

According to Gavin and McHenry (*loc. cit.*) the presence of choline which is one of the constituents of yeast extracts would explain the ability of yeast extract to prevent the development of fatty livers and their injury.

A. C. M.

Neanderthal Man in Italy

Mr A. C. BLANC discovered in February 1939 the fossil remains of a Neanderthal skull in the Guattari Cave, Monte Circeo, Italy. Particulars about the objects and their discovery are now available from a recently published article in *Revue Scientifique* contributed by the discoverer himself. The fossil skull was found on the bed of a chamber which is reached after passing through two other communicating chambers. It lay on the ground surrounded by a ring of stones. There are evidences which point out that this chamber was subjected to a prolonged flood. Marks on the skull also show that it remained half-submerged for a long time. "The disposition of the skull and the evidently intentional enlargement of the foramen, which has been completely destroyed, point to funerary and magical rites, possibly a ritual feast. This would account for the absence of skeletal bones". Monte Circeo skull is placed later in date than the Sacchopastore skull. The cave presumably remained undisturbed from Würm II, when it was closed by rockfalls, till its opening by Mr Blanc.

T. C. D.

LOW-TEMPERATURE DRYING OF FOODSTUFFS

RAPID freezing, with subsequent storage at low temperatures, is probably the most effective way of preserving the desirable properties of foodstuffs. If, however, the moisture present in the frozen foodstuffs in the form of ice is removed by evaporation in a high vacuum, the desiccated products can be transported and stored without the need for refrigeration, and there is in addition a large saving of weight. In view of these possibilities, a small-scale plant, designed to dry foodstuffs at low temperatures, has been in operation at the Low Temperature Research Station during the past year on behalf of the Food Investigation Board of the Department of Scientific and Industrial Research. Many different foods have been dried such as fruit, vegetables, fruit-juices, meat, eggs, butter and milk, and it is now clear that the products obtained are in general superior to those obtained by other methods of drying.

BOOK REVIEW

Essays in Polynesian Ethnology —by ROBERT W. WILLIAMSON, M.Sc. Edited by RALPH PIDDINGTON, M.A., Ph.D. Published by the Cambridge University Press, London, 1939. Pp. xlii + 373. Price 25s. net.

The name of Williamson is well known in the field of Polynesian ethnology. Before his death he collected a large number of notes bearing on different topics of Polynesian culture. The first part of the book under review is derived from these posthumous manuscripts. The five chapters of this part deal with warfare in Central Polynesia, Kava in Samoa, Tonga and other Polynesian islands; the society known as *Arioi*; and sex, courtship and infanticide in Polynesian society. The materials for these chapters were not derived from personal field-work but were collected from the vast literature dealing with Polynesia. Williamson does not seem to have examined the reliability of the statements of his authorities, which is necessary when one draws his materials indiscriminately from the writings of travellers, sailors, merchants, missionaries and scientific investigators. In spite of this defect, these accounts will be of real help to the future workers as they would find all possible information on the interesting topics collected in a nutshell. It is refreshing however to note that Williamson did not base any conclusion on these data but had merely narrated the facts as they had been recorded by his authorities.

Primitive warfare is rarely dealt with in anthropological literature. European domination over the coloured races, roughly for the last two centuries, has practically driven out of tribal life all relics of fighting, save and except family quarrels and village faction fights. Thus the trained anthropologist of today does not find any opportunity to study this institution under direct observation. He has to depend on the accounts left by his predecessors in the field—the travellers, merchants, soldiers and others of the kind. The chapter on warfare in Central Polynesia has the additional advantage of a number of traditional accounts which have preserved the details of

this native institution for the area under consideration. Kava is the "infusion of the roots of the plant *Piper methysticum*" which was the most important beverage of Central Polynesia especially of Samoa and Tonga. It was not a mere 'drink' but had been the centre of a complicated series of social and magico-religious ceremonials. It may be compared with the *Soma* of the Vedic Indians and the tea of the ancient Chinese and Japanese people. Kava is spoken of as the source of magico-religious inspiration to priests and preparers of this divine drink. The account of the *Arioi* places before us Williamson's views upon the "possible historical connection of this institution with the secret societies of Melanesia". The discourse on sex, courtship and infanticide introduces, us, among others, to the data relating to the "allegations of gross immorality of Polynesian women in their relations with visiting travellers". The customs of lending women and of the *Tayo* should not be studied out of their context. They were integrated with the socio-religious complex of ideas which dominated the life of the Polynesians and their ethical value cannot be judged with coloured eyes. This brings us to the end of the first part of the book.

The second part of this treatise has been written entirely by Dr Piddington. It consists of four chapters and an appendix which deal with the factors of stability and change in Polynesian culture, theories relating to the origin of Polynesian culture, relations between Polynesia and Melanesia, considerations about the past and present in Polynesia, and Assam parallels. These chapters do not merely aim at delineating certain Polynesian conditions but is "concerned with certain recent theories of Polynesian origins and these have a bearing on the controversy between the historical and functional schools." Anthropologists are now divided between the two schools—functional and historical, in place of the former evolutionist and diffusionist camps. The functionalists are accused of lacking in historic sense but Dr Piddington claims that they have too much of it and that is why they do not postulate past events on inadequate evidence. They do not hunt

for 'origins' but are interested in observing the social institutions in action. Of course, this does not mean that their study is an artificial cross-section of social life cut off from the main stream at a particular point of time just like a moving picture temporarily immobilized. They pay due considerations to both the past and the present and even do not hesitate to throw out suggestions for the future. Thus, according to our author, "differential emphasis is the real issue between the historical and functional methods."

In order to illustrate the superiority of the functional method over the historical one he turns his attention to a consideration of the historical ethnology of Polynesia and evaluates the attainments of the historical school in this particular field. "Throughout the Polynesian area we find a general cultural homogeneity, of language, religion, technology, and social organization, combined with certain striking differences between the various island groups." The attempts to explain these *striking differences* have in most cases led to the assumption "that there was an original archaic Polynesian culture, possessing certain features which may be seen surviving, though perhaps in a modified form, in the existing cultures of Polynesia; that by a process or processes of migration from outside Polynesia a new culture was superimposed upon this older one; and that features belonging to this more recent cultural influence may also be detected in Polynesia today, side by side with the co-existing archaic elements." Against this 'two-strata' theory differently named as Pre-Tangaroan and Tangaroan by Williamson, Indo-Polynesian and Tangaloa-Polynesian by Handy and Palae-Polynesian and Neo-Polynesian by Stimson, Dr Piddington suggests an alternative 'one-stratum' hypothesis. He assumes that "there was only one migration to Polynesia; that the migrants landed on one of the islands, increased their population, some of them subsequently migrating to other areas until the whole of Polynesia was populated; and that this was followed by a period of intermittent, occasional and unsystematic migration and cultural interchange between the various islands." He claims that there is absolutely no necessity to bring in a second cultural influx from outside Polynesia in order to explain the *striking differences* in the cultural traits already referred to. He is of opinion that Polynesian culture possesses both factors of stability and factors of change which are sufficient to account for the existence of these two types of cultural traits namely the so-called archaic and the intrusive ones. By an analysis of the social organization, religion and a particular trait-complex of material culture (Maori clothing) he shows that the archaic traits may reasonably develop into the so-called intrusive ones owing to the dyna-

mic forces inherent in Polynesian culture. The synoptic tables very clearly show the forces held responsible by Dr Piddington for this change.

In the appendix, which is especially interesting to the students of Indian anthropology, Dr Piddington exposes the weakness of Prof. Hutton's conclusion about the existence in the past of a cultural connection between Assam and Oceania founded on the similarity of certain cultural traits of Assam on the one hand and Fiji, the Marquesas and Madagascar on the other. Prof. Hutton attributes this similarity ultimately to diffusion from a common Indonesian culture which stretched its influence towards the east and west of Oceania and towards the north to Assam. While attributing similarities of traits within this region to historic connection, Prof. Hutton does not take into consideration the possibility of independent development nor does he try to explain the occurrence of parallel traits beyond this region, which cannot be explained on the basis of historic connection. To bring out more clearly the inherent impossibility of the situation, Dr Piddington mentions a number of parallel traits occurring in the Society Islands and among the Ashanti and also refers to parallels between Assam on one hand and Africa and America on the other. Evidently no explanation on the basis of historic connection is possible in these cases. Dr Piddington, however, does not categorically deny the possibility of historic connections under the circumstances but he draws our attention to the inadequacy of the proofs. In assessing the methodological approach of Prof. Hutton, Dr Piddington states that "the type of interpretation which has been criticised, even if correct, would reveal nothing which is relevant to modern scientific anthropology. On the contrary, the procedure adopted implies a negation of its basic principles; to dismember in a haphazard way an integrated human culture; to lump together disparate and unrelated cultural fragments . . . ; to tear elements of culture out of the context which alone makes them intelligible; to postulate migrations or processes of diffusion about which we shall never know anything significant, . . . all such procedures are not only irrelevant, but directly antithetical, to the method of approach, which has revolutionized the study of primitive culture." These are strong strictures which invite immediate refutation and we shall wait with interest for a reply.

We congratulate Dr Piddington for his clear exposition of the aims and methods of the functional school together with its view on the part which history should play in anthropological studies.

T. C. D.

Where Theosophy and Science Meet, Parts III & IV—Edited by D. D. KANGA, I.E.S. (Retd.). Published by the Adyar Library Association, Adyar, Madras. *Pp. Part III 260 & Part IV 223 with indexes. Price Rs. 2/4 each.*

The above publications fully maintain the excellence of the first two parts of the series. The monographs are very lucidly written and are as interesting as those in the first two parts. The efforts made by the editor to establish the main proposition, *viz.*, that theosophy and science have met, by the collective publication of these monographs on different branches of human knowledge, are really praiseworthy. A distinct and valuable service has been rendered by him for the cause of theosophy, as a perusal of these four volumes will give a good idea to the layman as to the real purpose and object of theosophical research. It is well known that a good deal of misconception exists in the minds of the non-theosophical section of the public about the doctrines of theosophy, which, according to many, mainly deal with spirits and ghosts and their doings. All such people will derive immense benefit by the perusal of the monographs contained in these volumes. Though the methods of clairvoyance have not yet been reduced to the same common denominator as the ordinary scientific methods of research, the greater the publicity given to the results of theosophical research, the greater will be

the understanding by all concerned, of the true significance of the theosophical method.

As to the different monographs contained in these two volumes, those on astrology, mystery of magnetic variation and mythology will be found to be particularly attractive. Students of science are invited to read them. They are sure to derive profit and pleasure by their perusal, though it is quite possible that the conclusions sought to be derived, may not be accepted in all cases. The symbolical interpretation of mythological stories is certainly fascinating. Such interpretations have also been given of the Indian *Puranas* by scholars and others, and the *Puranas* have actually been considered to be social and national histories of the ancient times expressed in symbolical forms, their contents being supposed to be intelligible as soon as the key for their interpretation is discovered. This view of the matter has, however, yet to be readily accepted.

Be that as it may, the reviewer has nothing but admiration for the great pains taken by Mr Kanga, the editor, in compiling these volumes. He deserves the greatest praise for the excellence of these publications. It is hoped that his laudable endeavour will be fully appreciated by the enlightened and educated public for whose benefit these books have been specially published.

H. P. B.

NITRATE INCREASE FOLLOWING SHORT FALLOW

PRELIMINARY results of an experiment at Woollongbar Experiment Farm have shown that, following a short fallow, the nitrate nitrogen content of the soil is considerably increased. The experiment in question was initiated to investigate changes in the amount of the various forms of nitrogen in "Big Scrub" soils brought about by various cultural practices, including green-manuring.

Half of the experimental plots were fallowed for about two months, the other half remaining under pasture. Analysis at the end of the above period showed that the plots under pasture contained an average of 4.5 parts per million of nitrate nitrogen, whilst the fallowed plots averaged 60 parts per million.

The effect of this greatly increased supply of readily available nitrogen on the establishment of sown pastures is being investigated.

—The Agricultural Gazette of New South Wales.

LETTERS TO THE EDITOR

The Distribution of the Root-Mean-Square of the Second type of the Multiple Correlation Co-efficient

The sampling distribution of R the multiple correlation coefficient of the one variate with $(p-1)$ other variates was worked out by Professor Fisher in 1928 under two different sets of conditions leading to different forms of distribution function. The first set of conditions consisted in the assumption that the bunch of readings in a sample for each of the $(p-1)$ variates remained constant from sample to sample, but only the bunch of readings for the first variate (whose multiple correlation with the $(p-1)$ other variates comes into the picture) changed from sample to sample; there were also certain additional well-known assumptions which are common to the usual theory of linear regression. The resulting distribution of 'R' is also well known and was quoted by us in a recent issue of *SCIENCE AND CULTURE*¹. This we shall call the first type of 'R' distribution. We found and announced in this Journal in the issue just mentioned that the root-mean-square of R is distributed (under the first type of conditions just referred to) in the same general manner (with only change of parameters) as 'R' itself. That is, the type of the distribution is conserved when we proceed to the mean. The second set of conditions consisted in the assumption that the variates constituted a multivariate normal population and that the bunch of readings for the $(p-1)$ other variates as also for the first variate changed from sample to sample. Under such assumptions it was found by Professor Fisher in 1928 that 'R' is distributed in the form

$$\text{Const. } R^{p-2} (1-R^2)^{\frac{n-p-2}{2}} dR$$

$$\times {}_2F_1 \left(\frac{n-1}{2}, \frac{n-1}{2}; \frac{p-1}{2}; \beta^2 R^2 \right) \quad (1)$$

where p is of course the numbers of characters, n is the size of the sample and β is the population value

for the multiple correlation of the first variate with the $(p-1)$ others. This we call the second type of 'R' distribution.

Considering m such random samples each of size n from a multivariate normal population and denoting the root-mean square of the different 'R's of the different samples by \bar{R} , we have recently found that \bar{R} is distributed in the form

$$\text{Const } \bar{R}^{m(p-1)-1} (1-\bar{R}^2)^{\frac{m(n-p)-2}{2}}$$

$$\times {}_2F_1 \left[\frac{m(n-1)}{2}, \frac{m(n-1)}{2}; \frac{m(p-2)+1}{2}; \beta^2 \bar{R}^2 \right] d\bar{R} \quad (2)$$

Comparison of (1) and (2) shows that the root-mean-square of 'R' under the second type of conditions is distributed in the same general manner (with change of parameters) as 'R' itself. The property that the type of the distribution is conserved when we proceed to the mean holds therefore for both the two different types of 'R' distribution.

Statistical Laboratory,
Presidency College,
Calcutta, 6-6-1940.

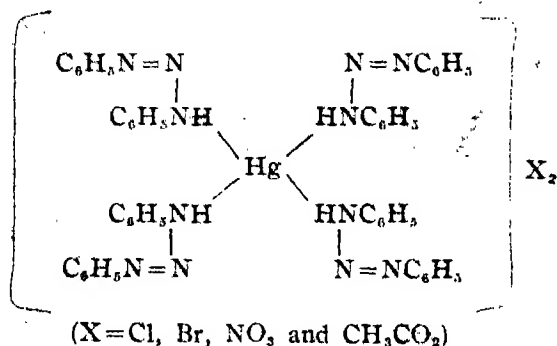
S. N. Roy
Purnendu Bose

¹ S. N. Roy and Purnendu Bose, *SCIENCE AND CULTURE*, 5, 714, 1940.

4-Co-ordinated Aryl Diazo-amino Mercuric Salts

That mercury could possess an unusual co-ordination valency of four was shown in a series of benzidine-piperidine mercuric compounds which included the complex halides¹. A number of 4-co-ordinated mercuric salts belonging to a different series have been prepared. These very interesting compounds contain diazo groups in the complex and are obtained by precipitating solutions of mercuric

salts with diazo-aminobenzene (m.p. 98°) dissolved in alcohol. They may be represented by the general formula,



only in shades. They are remarkably stable in air, light having no action on them. All of them are insoluble in water but dissolve readily in chloroform. They melt with decomposition, the chloride melting at 220°C . That mercury can attain a maximum co-ordination valency of four even in the complex halides is, therefore, further proved by the preparation of this new series of organo-mercuric compounds.

Chemistry Laboratory,

Presidency College,

Calcutta, 5-6-1940.

Kanai Lal Mandal

The diazo-amino mercuric compounds are brilliant yellow in colour and differ from one another

¹ Kanai Lal Mandal, SCIENCE AND CULTURE, 5, 719, 1940.

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Wanted a National Fuel Policy

THE National Planning Committee, in one of its recent sittings, has passed the following resolutions, referring to the problems of power and fuel in this country :

We recommend that in view of the fundamental importance of power development, the huge capital investment required, and because it may involve the interests of more than one province or State and for other reasons, the State should develop a definite National Power and Fuel Policy on the following lines :

(a) That all power and fuel resources of the country should be regarded as national property and should be fully conserved, scientifically developed and utilized, with a view to bringing power, particularly electrical power, at the service of everybody, for domestic and industrial use, at the cheapest rate;

(b) As the generation and distribution of electricity is a public utility of great importance, the State should ultimately own it and the control and management of it should be exercised by the Electricity Boards, as hereinafter provided for;

(c) That the State should take the initiative to bring into existence all future schemes of regional power developments and public power supplies, particularly hydro-electric stations inasmuch as the working of such stations depends on the use of water resources which, however, have multifarious other uses affecting extensive areas and large populations, e.g., for irrigation and navigation, for drainage and soil conservation; further because the State alone is in a position to reconcile and integrate all features of power schemes, financial success, cheap servicing, use over wide-spread areas, and land acquisition and settlement of populations;

(d) That in view of the limited reserves of coal, which cannot be replenished, and are indispensable for such essen-

tial industries as smelting of iron ore, production of synthetic dyes and other essential chemicals and because of the finding of the Coal Mining Committee of 1937, that coal is being mined, processed, and marketed in a very wasteful way, greatly injurious to the interests of the nation as a whole, very strict State control should be exercised on all phases of the coal industry. Further, in regions far removed from coal fields, coal for power production should, as far as possible, be replaced by hydro-electric and other resources.

With respect to COAL, the most important fuel, they have adopted a further resolution :

We consider that in the interests of the nation it is imperative that coal mines and the coal mining industry, as well as the oil fields and other sources of natural fuel, should be completely nationalized. This industry should be conducted by a National Fuel Board, with sections for production, processing, research and utilisation; and distribution and marketing and transport. Research work should be started immediately.

The National Planning Committee has thus recommended "*Complete Nationalization of Coal Mines*". If this proposal is to be given effect to, the landlords and coal miners will have to be expropriated, and the industry should be conducted by a National Fuel Board in the interests of the nation.

This proposal of the National Planning Committee may appear to many of our readers revolutionary, but when they care to study the present-day position of coal mining, as described in detail in the accompanying article, they will probably rise with the conviction that not only is the proposed measure absolutely necessary, but they will also wonder how

the present frightful waste of one of the most precious of national assets of the country could be tolerated for such a long time!

Our article has been compiled from the *ad interim* report of the Power and Fuel Sub-Committee of the National Planning Committee, which again is largely based on official records, mainly on the findings of the Coal Mining Committee of 1937 and the Coal Grading Committee of 1925. In this connection, we may invite attention to the views of the Coalfields Committee appointed by the Government of India in 1920, as expressed in the following lines from their report:

"Coal is a national asset on which the manufacturing industries and the commercial expansion of the country depend. A landowner or colliery proprietor is at present in a position to waste this national asset without restriction. By such waste he may obtain immediate financial benefit, but he injures the country, damages his property and diminishes the estate of his heirs. We hold that the State has the right, in the interests of the community, to step in and prevent the dissipation of the country's resources. Indian coal is not inexhaustible and scientific mining methods are needed for its conservation and economic extraction".

The picture of the coal mining industry, as revealed in our article, has been known to the India Government for a long time, but so far they have not mustered sufficient courage to adequately deal with the problem. That the bureaucracy is fully cognizant of the problem will be apparent from the following extract from a speech by Sir James Sifton, the then Governor of Bihar and Orissa, delivered at the Annual Dinner of the Geological, Mining and Metallurgical Institute of India on January 15, 1937:

"I feel sure that most of you will agree that there was an initial mistake; that the coal of a country is a national asset, that it ought to be protected by Government from wasteful exploitation for ephemeral profit, and that the *laissez-faire* policy applied to irreplaceable national wealth is exploded and out-of-date."

"The pitiful part of the history of the coal-fields is the absence in the past of Government intervention and the aloofness of Government from the

problem of getting the best out of the mineral wealth of the country".

After the publication of the report of the Coal Mining Committee, even the Government of India, woke up for a little while, and passed an Act providing for sand stowing in the mines. But this measure, useful as it is, does not even touch the fringe of the problem. A valuable and irreplaceable national asset is being wasted in a wanton fashion, and this spells disaster to the iron-smelting and other key industries. Should this waste be allowed to continue?

Further, this problem and the measures suggested are not peculiar to India. Most countries, democratic as well as fascist, have found it necessary to nationalize the coal mining industry. Even in the United Kingdom, the strongest citadel of plutocratic democracy, the Conservative Government passed an Act in 1938, completely nationalizing the coal mines. The Act was, under normal circumstances, to come into operation from 1940. Will not our Government rise equal to the occasion, and put through the legislature an Act which is long overdue, nationalizing the coal mining industry in all its various stages,—prospecting, mining, processing and marketing? Times are fast changing and there has been enormous depletion of the natural resources all over the world for maintaining human life and improving the standard. It needs hardly be pointed out that opportunities for receiving from other parts the essential commodities for a country will be more and more scarce. We have therefore raised this problem of the indifferent fuel policy of the Government of India once again. We are planning for industrialising the country to improve the economic condition of our people and fuel forms the backbone of that industrial structure of a country. There are signs, however, that the Government have very lately modified under great duress their indifferent attitude towards the country's problems and are utilizing scientific knowledge and scientific talents to some extent for the purpose of rehabilitation of our country's decaying resources. We feel that much more has to be done in making State policy in this country responsive to the national needs in accordance with expert scientific advice, and the fuel problem being a central problem we would ask the Government to take concrete steps immediately in the light of the recommendations of the National Planning Committee.

Coal Industry in India*

USES OF COAL

COAL is used in India for the production of electrical power, for the running of railways, for propulsion of ships, for running other industries with steam power, for smelting purposes, for such industries as glass, cement, etc., and for domestic purposes. A small quantity is used for conversion into gaseous

for conversion into liquid fuel, when mineral liquid is not available.

The total production and consumption of coal under different headings are given below :—

TOTAL RESERVES OF COAL

According to the Geological Survey of India, coal reserves of different varieties up to one foot

TABLE I

TOTAL PRODUCTION OF COAL IN INDIA

Year	1935-36	1936-37	1937-38	1938-39
Total production in million tons ...	20.87	20.06	23.479	24.8

TABLE II

TOTAL CONSUMPTION OF COAL IN INDIA

Consumers	Estimated consumption in 1927 (in tons)	Per cent total	Estimated consumption in 1935 (in tons)	Per cent total
Railways :	7,259,000	33.5	7,259,000	31.9
Admiralty and Royal Indian Marine	27,000	0.1	29,000	0.1
Bunker Coal	1,317,000	6.1	1,020,000	4.5
Jute Mills	935,000	4.3	653,000	2.9
Cotton Mills	630,000	3.8	1,531,000	6.7
Iron Industries including engineering work-shops	5,260,000	24.2	5,583,000	24.4
Port Trust	205,000	0.9	135,000	0.6
Inland steamers	636,000	2.9	551,000	2.4
Brick Kilns, Potteries, Cement Works, etc.	565,000	2.6	792,000	3.5
Tea Gardens	223,000	1.0	186,000	0.8
Paper Mills	156,000	0.7	171,000	0.7
Collieries and wastage	2,208,000	10.2	1,220,000	5.3
Other forms of Industrial & domestic consumption	2,085,000	9.7	3,712,000	16.2
Total	21,706,000	100.0	22,842,000	100.0

fuel. In other countries it is further used as a source of raw material for the manufacture of a large number of chemicals of great economic value, and

thickness of seams and within 1000 ft. is 60,000 millions tons, found to be mostly in the Gondwana Basin. The total workable coal is estimated to be 20,000 millions tons. Of these the coking coal, which alone at present can be used for iron smelting is only 1500 million tons within 2000 ft. of the ground

* With acknowledgement to the National Planning Committee. The materials are collected in the report of the Power and Fuel Sub-committee of the N. P. C.

surface. The following tables are taken from Dr Fox's Book.

I

TOTAL COAL RESERVES

	Million tons.
1. Darjeeling and Eastern Himalayan region ...	100
2. Giridih, Deogarh and Rajmahal Hills ...	250
3. Raniganj, Jharia, Bokaro and the Karanpura Fields ...	25,650
4. Son Valley—Auranga to Umaria and Sohagpur ...	10,000
5. Chhattisgarh and Mahanadi (Talcher) ...	5,000
6. Satpura region—Mohpani to Kanhan and Pench Valley ...	1,000
7. Wardha-Godavari-Warora to Badadanuru ...	18,000
Total ...	60,000

II

RESERVES OF WORKABLE COAL

	Million tons.
1. Darjeeling foothills, Lisu-Ramthi area ...	20
2. Giridih, Jainti and Rajmahal Hills ...	80
3. Raniganj, Jharia, Bokaro and Karanpura fields ...	10,150
4. Son Valley—Hutar to Umaria and Sohagpur ...	2,000
5. Chhattisgarh and Mahanadi (Talcher) ...	1,200
6. Satpura region—Mohpani to Kanhan and Pench ...	150
7. Wardha-Godavari-Warora to beyond Singareni ...	6,400
Total ...	20,000

III

RESERVES OF GOOD QUALITY COAL

(both coking and non-coking)

	Million tons.
1. Giridih and Jainti ...	40
2. Raniganj ...	1,800
3. Jharia ...	1,250
4. Bokaro ...	800
5. Naranpura (North and South) ...	750
6. Hutar, Jhilla, Burhar ...	50
7. Kurasia, Jhilmili, etc. ...	30
8. Talcher to Korba ...	200
9. Mohpani, Kanhan-Pench ...	30
10. Ballalpur-Singareni ...	50
Total ...	5,000
Coking coal ...	1,500
Non-coking coal ...	3,500

The total good quality coal excluding the coking coal which can be profitably used for conversion into liquid fuel is only 3500 million tons. The coal reserves of India, so far as it is known, are very small compared to those of U.S.A., U.S.S.R., England, Germany and even to those of Japan and quite insufficient for a big country like India.

FAULTY CONSUMPTION OF COAL

Misuse of Coking Coal : The coking coal, which ought to be exclusively reserved for smelting purposes is now being used mostly for other purposes. In 1935, 11.5 million tons of coking coal were raised and only 2.5 million tons were used for smelting. The rest was used for purposes which could be served by other varieties of coal. It is feared that this sort of misuse will continue unless it is stopped by the Government.

According to the findings of the Coal Mining Committee, (1937) the entire known reserves of coking coal will be depleted in about 60 years, after which the metallurgical industries will be faced with a serious situation for though India has got iron ore of very good quality in enormous quantities, she possesses proportionately less of coking coal required for its conversion to pig iron which is the basic material for all machineries. At the present rate of wastage of coking coal, after about sixty years, the iron-smelting industries would come to a standstill unless some technical process is discovered by which iron ores can be worked by other varieties of coal. India will then be forced to export her ores just as Sweden does at present, because though she has the best ores, she has practically no coal for smelting the ores.

Misuse of Superior Grade Coal : At present, most of the coal raised is of good quality ; 20 million tons in 1936 out of 23 million tons. At this rate, according to the findings of the Coal Mining Committee, 1937, the good quality coal will be exhausted in about 120 years, provided the recovery is 50%.

The superior coal should be reserved for such purposes as hydrogenation of coal to liquid fuel, as well as for blending.

Improper and Inefficient Utilisation of Coal : In this country, coal raised from the mines is stored and handled in a wasteful way, and is consumed mostly in the raw state, without any prior processing according to the needs of the consumer. The little processing

which is done by the coal-processing industries (*e.g.*, manufacture of 'hard' and 'soft coke') is wasteful from the point of view of recovery of valuable bye-products such as tar-products, ammonium compounds, gas (in the case of 'soft coke').

It is therefore desirable that methods should be adopted for the recovery of the bye-products—gas and tar—produced in the manufacture of 'soft coke'. It has been estimated that on the most conservative basis in the Jharia coalfields alone, some 30 million gallons of tar comparatively rich in motor spirit, light oils and other substances are being wasted every year. As the 'soft coke' industry is confined within the restricted area of the Jharia and Raniganj coal fields, every 'soft coke' manufacturer should be under statutory obligation to recover the tar for further treatment in a central tar distillation plant working under State control.

It is well known that some of our inferior grade coals, considered unsatisfactory for steam raising in the usual manner, can become quite good for this purpose if made into pulverized fuel. The fusibility of the ash is the most important determining factor in this connection and a systematic investigation into the grading of II class coals, on the basis of the fusibility of their ash, may result in the use of those coals with nonfusible ash for steam raising purposes, thus conserving the high grade coal. The washing of coal has been extensively adopted in other countries to improve the quality and quantity of coal ash in lower grade coals.

Some of II grade coals are also considered unsuitable for 'soft coke' making as they do not give the light and spongy structure to the coke necessary for easy burning. If by suitable treatment in the process of coking, this object is achieved it would find an important outlet for some of these coals for which at present there is poor demand, and release a certain portion of the better grade coal now converted into 'soft coke'.

DEFECTIVE MINING METHODS

It has been established beyond doubt by the findings of several committees such as the Coalfields Committee, (1920), the Coal Mining Committee, (1937), and some independent authorities (Drs Fermor and Fox, Mr R. R. Simpson, Chief Inspector of Mines, Prof. S. K. Roy and several others) that the Indian collieries are responsible for the following

practices which cause loss of valuable and irreplaceable national property :

- (a) Too much extraction is attempted in first working, which weakens or thins the supporting pillars with consequent collapses, fires, flooding, etc.
- (b) Cheap mining operations are often conducted which involve a considerable loss of coal as not much care is taken to plan the underground workings.
- (c) The practice of rotational working, *i.e.*, extraction of superior coal seams before the extraction of upper seams is in vogue in many collieries. The upper seams may be little inferior but no adequate measures for protection of the upper seams, such as sand stowing, are adopted. This bad practice which is followed mainly for profit purposes has resulted in heavy losses of good coal in Jharia and Raniganj, caused by the subsidence of the overhanging seams.

Besides these losses, a large amount of coal is buried under railways, roads and rivers and steps should be taken for their working. For the wastage in mines, the landlords are largely responsible, for they do not exercise control, which is expected of them, on the colliery owners. For immediate financial gain they lease out coal areas which are not economic. They do not take action against colliery owners who abandon mines on account of fire, subsidence or for reasons of economy, and even when they have been compensated for their own share of the royalty which barely amounts to a fraction of the intrinsic property of the coal, they allow valuable national property to be permanently wasted.

The absence of any substantial control on mining, handling and utilisation causes very serious losses to a valuable national property, and one unacquainted with the conditions of India's coal mining industry is surprised why such a wasteful system is continued. This is mainly because the value of coal to national life has not been recognised in this country, and coal is not regarded yet as a national property.

The colliery owners are mainly guided by profit motive, and in the absence of control, have adopted and have been continuing wasteful methods in mining, handling and storage, because they are cheap and enable them to market coal in an uncontrolled

market at a competitive price. It has attracted a far larger amount of capital on account of the prospect of ready gain and the industry has been in a state of chronic depression on account of lack of organisation amongst colliery owners, leading very often to overproduction, cut-throat competition, decrease in price for which the State, being one of the principal producer-consumer, is also responsible. A big producer-consumer when allowed to offer tender for his own purchase can always turn the situation in his favour, even though producing that commodity at a higher cost. This has been the case with Indian Railways.

Moreover, prices of coal in this country which are rather too low in comparison to those in Europe and America have delayed any voluntary attempts to increase the efficiency of utilization—being not worth the salt. From these considerations, it is essential that early steps should be taken to ensure an economic stability to the coal industry which is a pre-requisite to conservation.

CASES FOR STATE CONTROL

The above analysis shows that an irreplaceable and invaluable national property is being wasted. The complications are such that the only body which can take efficient steps for the safeguarding of this valuable public property is the State, but it has refrained from taking any serious action in spite of the recommendations of its own committees and experts; the chief plea being that the State cannot intervene and infringe the rights of permanently settled Zemindars in Bihar and Bengal. Even in C. P., where the mineral rights are owned by the State, no action has been taken for the prevention of waste by the colliery owners.

But in no other countries is such wastage tolerated, some kind of control is invariably exercised over the whole range of operations from mining to consumption.

THE PRINCIPLES GUIDING STATE CONTROL

It is desirable that the State should exercise strict control over the coal industry for the following reasons:

- (a) Coal is a valuable and irreplaceable commodity which is regarded as a national property in all countries.
- (b) It is one of the chief sources of power, the basic material for transport and industries and its importance to India is all the greater on account of scanty resources of oil in India.
- (c) With the coal industry is associated the prosperity of the iron and steel industry—one of the key industries.
- (d) It is one of the important raw materials for synthetic chemical industries (dyes, drugs, antiseptics, etc.).
- (e) With the prosperity of the coal industry is linked up the welfare of a large number of people engaged in coal mining.
- (f) The control will bring about economic stability to the coal industry, which is one of the indispensable steps in reducing waste in mining. So long as coal mining is carried on in a state of chronic depression, little progress in reducing the present wastes can be hoped for, even in the face of statutory regulations. It can, at the utmost, result in increasing the number of abandoned mines.

Some Aspects of Crop Production with Special Reference to Manures and Fertilisers

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INTRODUCTION.

IN growing a crop the two principal considerations are—which variety to use and how to grow it. These necessarily link agriculture with plant breeding on the one hand and plant physiology on the other. While the former is useful in providing to the investigator plant material more homogenous in form and function, the latter is helpful in elucidating the nature of intrinsic variabilities so characteristic of the species in changing environment. The farmer however is chiefly concerned with the plant, the weather, the soil and manures but is hardly conscious of the general biological environments under which the plant grows. For him the plant is the centre of the subject, and a visible and living agent by which the materials gained through the soil and the atmosphere are synthesised for the service of man and beast. For successful farming the endeavour of the agriculturist will be to provide conditions such that the plant will reach the ideal in view. This can most effectively be achieved when a scientific analysis has been made of the nature, of the interactions between the several edaphic factors of which the mechanical, chemical and biotic conditions are the main, and the series of other environmental factors—radiation, temperature, humidity, wind velocity etc., with special reference, of course, to the plant species under consideration, and of the functions that the different organs of the plant inherently perform to increase the output of matter.

DETAILED STUDY OF FACTORS NEEDED

In considering such a rôle of complementary factors, operating simultaneously or otherwise, attention is more closely drawn to such conditions as are liable to be controlled economically and to better ends. Of the controllable factors in crop

production may be mentioned soil cultivation and crop rotation. Our knowledge of these is still largely traditional and no longer suited to the modern scientific concept of plant life or its requirements. The secret of the problem lies in discovering not merely the extent to which treatments affect yield but how in terms of component growth factors, this is brought about. This however does not preclude the other view commonly held that the maintenance of soil fertility on the farm consists in replenishing the plant food removed by the crop, although such a view does not take into consideration the several losses of calcium and nitrogen due to leaching and gaseous diffusion, the conversion of available forms of potassium and phosphates into unavailable forms, the continuous loss of organic matter and the changes simultaneously brought into the soil by continuous cropping. The old method of correlating final yields and totals consisting of both effective and ineffective units would no longer hold good in the present age of scientific agriculture. The response must be measured in terms of diverse plant activities at different stages in the plant's life cycle. The plant's activity must necessarily be reasoned out with reference to effective soil and meteorological conditions—the microclimate. It is only then that the ultimate aim of devising the best system of cultivation, resulting in increased output and quality of produce, can be achieved.

From practical viewpoint, however, the ultimate aim of every experiment connected with manures is to devise the best system of cultivation, which may finally result in an increased outturn and in the improvement of the quality of the produce. Cultivation includes a number of agricultural operations, of which manuring and irrigation are important items. On reviewing the problem of manuring the following aspects, both fundamental and practical,

come to the forefront. (1) What are the elements essential for the normal development of the plants? (2) What are the different levels (concentrations) of these ingredients needed singly or in combinations for optimum growth? (3) What is the ultimate form in which these constituents may be taken up by the plant and utilised in increasing the yield and the quality of the produce? (4) What must be the most appropriate method and time of application of these ingredients in the forms determined to be most useful in answer to the third question? (5) What is the relation between the water requirement of a crop and its nutrient intake? (6) How far is the relative absorption of different elements at various physiological stages of the plant responsible for fluctuations in the rate of dry matter production? (7) What is the ultimate fertility of the field under the different manurial treatments in view of the available and total ingredients present in the soil?

Apart from these studies in plant nutrition, the influence of another set of variants, *viz.*, atmospheric variables which have a direct bearing upon the growth and development of a plant and upon the final yield must concurrently be analysed. The significance of these factors is not sufficiently appreciated as evident from the data so far collected at the different experimental stations. These stations are situated under widely varying conditions of climate and hence the need for the maintenance of crop-weather data. Daily records of the weather conditions (soil temperature, air temperature, humidity, rainfall, solar radiation etc.) have to be maintained. Simultaneously the growth efficiency of plants along with the final yield of similarly treated plots have to be recorded. After the accumulation of comprehensive data over several years, the plant response should be analysed in terms of each atmospheric variable. Every manurial trial extending over several years must be supplemented with complete weather records so that while analysing the data in terms of various manurial combinations the influence of individual atmospheric variables may be eliminated.

It may be mentioned in this connection that modern researches in the realm of plant physiology have indicated that the rate of any functional activity, be it assimilation, respiration or growth, is not determined by one and only one factor, or the "speed of the slowest factor" conditioning the process, but by the availability of each of the complementary factors in the environment of the plant. All experimentation with the effect of one or two

factors therefore needs to be devised in such a way that the factors, the effects of which are not under consideration, are necessarily kept above their limiting value. Such a condition is a necessary adjunct to any sound experimental procedure but it is regrettable to note that in very few cases only is this kept in view. Greater stress should be paid to the design of multi-factorial experiments with fertilisers, irrigation, cultivational operations, varieties etc., such that the interaction between these factors may be studied. It is here that a very close co-operation between the statistician, the agronomist and the physiologist is needed.

CROP-ROTATION PROBLEM TO BE KEPT FOREMOST IN VIEW

As all fertilisers have a direct or indirect influence upon the soil which often lasts for years, the fertilisation of crops should be studied from the standpoint of rotation in which they are grown. The object of most fertiliser experiments in India has been to determine the quantities of nutrients that should be supplied to our crop under varied soil and climatic conditions and in accordance with our cultural practices. These factors vary so widely that it is probable that the ideal application is seldom approached closely to the requirement of the crop. The kind of fertiliser a farmer should apply and the most profitable amount for him to use are always somewhat of a guess though his practice may be based on the experimental evidence from a particular area. However, experiments must be continued to work out the fertiliser requirement of crops specially from the point of view of the varying needs of the cultivators. The question whether we recommend correct fertiliser ratios to the cultivator, should always be borne in mind while suggesting any specific ratio. The traditional policy of recommending one or other fertiliser merely because this was found in abundance or because it was produced cheaply, has its disabilities.

VALUE OF LEGUMES IN MAINTAINING SOIL FERTILITY

It is often proposed that the fertility of the soil so far as nitrogen is concerned should be maintained by the turning under of leguminous green crops. There is no doubt that such a practice would aid in solving the so-called nitrogen problem but it cannot be considered as a general solution of the entire

problem. It is not always profitable to turn under a legume crop either for the nitrogen or the organic matter or both which it may contain. Where intensive farming is employed land is too valuable to be used in the production of the common green manuring crops. Furthermore in areas where rainfall is a limiting factor the process of turning under the soil of leguminous crops is highly objectionable inasmuch as the decay processes would take place at a very slow rate. Again legumes, in general, when used in rotation as one of the principal crops require for their best growth a soil that is free from excessive acidity and one that is well supplied with plant nutrients, and as such fertilisers have to be added if profitable legume crops are to be grown. In any system of soil management there are many other factors besides the organic matter and soil nitrogen content, which exert a major influence on crop yield. Soil moisture has probably greater influence than any other factor taken singly. Likewise tillage conditions are greatly responsible for maintaining a suitable physical condition of the soil for plant growth and microbiological activity.

STANDARDISATION OF METHODS NECESSARY

Many investigators in the West have also attempted to so standardise fertiliser practices that definite and specific systems of fertilisation have been advocated. The Wagner system, the Ville system, the Hopkins system, the system based on the composition of the plant, the cash-crop system of fertilisation and many others are some of the commonest systems of fertilisation advocated. There is again the need for standardising such methods from the cultivator's point of view as also the desirability of testing the efficiency of other outstanding methods of determining mineral deficiency in soil such as those developed by Neubauer, Hoffer, Thornton, Troug, and Sackett. Equally necessary is the classification of crops on the basis of the response to individual nutritive elements under different conditions of growth.

The method of applying fertilisers under field conditions best suited to a particular crop also needs investigation. In foreign countries fertiliser distributing machineries are mainly of two types; first, implements which are designed principally for the application of fertiliser, and secondly, implements

which have been designed as attachments to apply fertilisers along with such other field operations as planting or cultivation. In India however manual labour is utilised for such purposes. In all such cases it is absolutely necessary to see that the fertilisers are uniformly distributed. If this is not done, the soil becomes spotty in fertility and this results not only in an uneven appearance of the crop but it also seriously interferes with the even maturing of the crop. The question of applying the fertiliser with reference to the relative position of the seed and the fertiliser specially in a crop like sugarcane is an important aspect; and this should be carefully worked out for each of the crops before detailed trials on a large scale are taken up.

CONCLUSION

The point to be kept foremost in view in all experiments with crops and fertilisers is that soils are dynamic. Physical, chemical and biological changes are continuously taking place in the soil and these changes acting in unison with climatic factors and the plant itself influence the efficiency of any fertiliser. Crop production is a process of biological adjustment between heredity and environment, between the natural forces working in the soil and the atmospheric factors; and man's effort to modify them is of immense value in all agricultural practices. For each crop there is the need for determining what may be called the optimal conditions under which best growth both in quality and quantity might be possible. Further agricultural research should be based on this fundamental principle, *viz.*, of studying crop response to fertilisers from an economic as well as a metabolic point of view with as many factors varying simultaneously as practicable. Equally important from the practical viewpoint is the accurate determination of the individual environmental coincidence (by coincidence I mean the optimal inter-relations of all growth factors to which a plant is subject) under which an agricultural industry must operate in a given area. In all such cases the centre of the subject of crop production must always be the plant itself, as this can more effectively be studied in relation to the soil in which it grows, to the conditions of village agriculture under which it is cultivated and with reference to the economic uses of the ultimate products for which it is grown.

Magnetic Storms

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MAGNETIC storm is one of those intriguing geophysical phenomena which arouse interest in the scientific as well as in the lay mind. Scientific interest is stimulated because the origin of many of its features is still shrouded in mystery while the public become inquisitive because its incidence is heralded by dislocation in telegraph, telephone and radio services. In the present paper an attempt is made to give a concise account of the magnetic storm and to describe the theories which have been put forward from time to time to explain its origin.

THE EARTH AS A MAGNET

It is well known that the earth behaves as if it were a huge magnet and that due to its attracting influence a magnetic needle placed anywhere on the surface of the earth points approximately towards the north. The directive property of a freely supported magnet was known as early as the eleventh century and was applied to the construction of the mariner's compass some time later. But the fact that it is the earth which behaves like a magnet and exerts the directive influence on the compass needle was not known till comparatively recent times. It used to be believed as late as the sixteenth century, that a magnetic needle points northwards because it is attracted by the Pole Star. It was only in the year 1600 that William Gilbert, the famous physician to Queen Elizabeth, told the world of the true reason of a magnetic needle pointing northward.

VARIATIONS OF THE TERRESTRIAL MAGNETIC FIELD— MAGNETIC STORMS

Most people are under the impression that the magnetic field of the earth is constant, that it does not alter with time; the direction in which a magnetic needle points is fixed once for all and is unalterable. This, however, is by no means so.

The magnetic field at the surface of the earth is a changeable one. There are, broadly speaking, two types of change. One, a very slow one, the effect of which can only be detected in decades or centuries and the other, rapid ones, which produces measurable effects in days, hours, or even minutes. As an instance of the first type of change the following may be mentioned. The magnetic needle in London used to point 10° east of north in the sixteenth century. The direction gradually changed

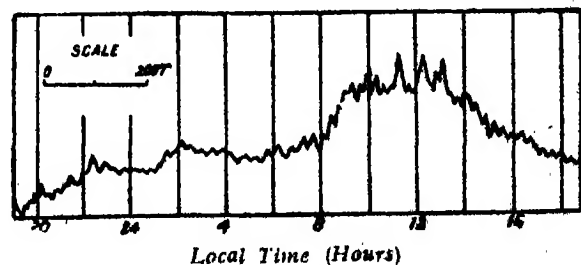


FIG. 1.

Typical magnetogram showing variations of the horizontal component of the magnetic field on a magnetically disturbed day.

Note :—The range of variation is about 200γ, whereas the total field is of the order of 30,000γ.
 $1\gamma = 1/100,000$ Gauss.

and in the year 1818 it pointed 20° west. Since then it has been slowly swinging back and now points 11° west.

As regards the second type of variation, the quick ones, the reader is referred to Fig. 1. This is a sample of a 24-hour record made at a magnetic observatory. The curve shows (if the smaller variations are disregarded) that the horizontal component of the earth's magnetic field has changed from a minimum value at about midnight to a maximum a little after noon. This regular variation of the magnetic field is known as diurnal variation. There are some days on which the indentations on the curve are small; such days are called magnetically quiet days. The days on which the record is heavily indented, as represented in Fig. 1, are called magnetically disturbed days. It will be noticed

that the magnitude of the change of the force is quite small compared to the total force. In fact it is only a few thousandths of the total field. For a critical study of such periodic variations—which are related to the solar and the lunar time—analysis of a large amount of records collected from a large number of observatories is necessary and the process is both laborious and tedious. The regular diurnal variation of the horizontal magnetic intensity on magnetically quiet days obtained from such analysis is depicted in Fig. 2.

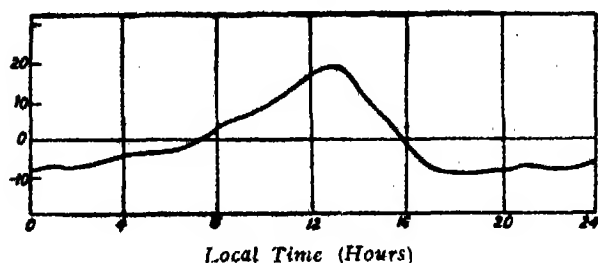


FIG. 2.

Diurnal variation of horizontal component on magnetically quiet days. The ordinates represent the intensity in γ units.

Besides these variations there is another type of quick variation which is depicted in Fig. 3. Here it will be seen that the disturbance starts with a rise of the magnetic force and is followed by a large and sudden decrease in course of a few hours. Such sudden changes in the magnetic field of the earth are known as magnetic storms. The increase is called the first phase and the decrease is the second or main phase of the storm. After this follows the phase of recovery. It might take a few days before the force recovers its normal value. There is one important difference between the variation of the type depicted in Fig. 2 and that in Fig. 3. The



FIG. 3.

Changes in magnetic force (horizontal component) during a magnetic storm. Note that the hours do not indicate local time but are reckoned from the commencement of the storm. The changes occur simultaneously all over the world.

variation in Fig. 2 is related to the local time, i.e., the maximum and minimum of the curve occur regularly at the same local time and not simultaneously at different places on the earth's surface. The violent changes during the magnetic storm, however, are not in any way related to the local time and occur simultaneously all over the world. This is a characteristic feature of the magnetic storm.

ORIGIN OF THE VARIATIONS

One may now ask what is the origin of such magnetic disturbances? Or perhaps one may start by asking what is the origin of the magnetic field of the earth due to which the mariner's compass always points to the north? If the earth were made of steel, one could have imagined that this huge sphere of steel has by some chance been magnetised and the magnetic field at the surface of the earth is due to this magnetisation. But we all know that the surface crust at least of the earth is not made of iron. It may be that deep inside, the core of the earth is made of iron and nickel which can be magnetised. This however, does not help matters. The interior of the earth is extremely hot and it is well known that at such high temperature steel loses its magnetic property. It must be admitted that there is at present no satisfactory explanation of the origin of earth's magnetism.

Next, one might want to know the reason of the slow change of the earth's magnetic field. How is it that the magnetic needle in London which was pointing slightly north-east at the time of the good queen Elizabeth has slowly changed its direction and is now pointing north-west? What physical changes have been going on inside the earth which could have altered the magnetic field of the earth and swung the needle in this fashion? Here again it must be confessed that the cause is not known.

We now come to the regular diurnal variation of the magnetic force which occurs in course of 24 hours as depicted in Fig. 2. Here we are on surer grounds about the cause. The phenomenon is closely associated with a similar variation of the pressure of the atmosphere which is of world-wide occurrence. In fact, the origin of this regular diurnal change of magnetic force lies not inside but outside the earth. This startling discovery was made by a famous scientist Gauss from purely mathematical reasoning. It is not possible in this short note to go into the details of this interesting phenomenon.

but an attempt may be made to explain it in a general and simple way. The atmosphere covering the earth might be compared to an ocean of air. Just as in the ocean of water tides occur due to the attraction of the sun and the moon so also in this ocean of air tides are generated by the pulls of these two heavenly bodies. There is ebb and flow of air over any point of the earth's surface just as there is ebb and flow of water due to the tides. Now, the atmosphere in the ionosphere, beyond 50 kilometres, is conductor of electricity. When this conducting atmosphere moves from side to side due to the tides, it does so in the magnetic field of the earth. The inevitable thing then happens. According to the well-known law of electro-magnetism electric currents are generated in the conducting atmosphere in much the same way as currents are generated in the armature of a dynamo. These currents produce an extra, feeble magnetic field at the surface of the earth which varies in sympathy with the ebb and flow of the atmospheric tide occurring in 24 hours. The variation of this extra magnetic force produced at the surface of the earth is the cause of the variation depicted in Fig. 2.

The magnitude of the electric current system in the high atmosphere required to produce the observed variation has been calculated by Bartels. At this season of the year a current of nearly hundred thousand amperes circulates in the high atmosphere above the sunlit portion of the northern hemisphere. As the sunlit portion of the atmosphere moves from east to west the whirling current also moves with it producing the regular diurnal variation shown in Fig. 2.

ORIGIN OF MAGNETIC STORMS

What now is the origin of the sudden and violent changes of the magnetic field which we call magnetic storms? Is it due to a sudden change in the magnetisation of the earth or to some electric current system generated outside the earth by some unknown agency? Careful computation shows that here again the origin is not inside but outside the earth and must be due to a huge belt of current, suddenly generated, encircling the earth round its equator probably at a distance of a few thousands of kilometres. How is this current, the strength of which is estimated to be several hundreds of thousands of amperes, produced? Unfortunately, here again no very definite and conclusive hypothesis

has yet been formulated. The most probable theory which is believed to be correct in its essentials is that due to a well-known Norwegian scientist Carl Störmer. It is believed that the sun sends out not only light and heat but also electrified particles of tremendous speed. Störmer has shown that magnetic storms and auroral displays are associated with the encounter of the earth with these electrified particles. A beam of fast-moving charged particles is but like an electric current and is influenced by a magnetic field. Such a beam, on approaching the earth, may be caught by the latter's magnetic field and when this happens some of the particles sweep down into the earth's atmosphere near the polar regions causing auroral displays and some others swing round producing a ring of electric current round the earth which causes the magnetic storms (Fig. 4). This theory, known as the solar corpuscular theory, is yet incomplete and has still

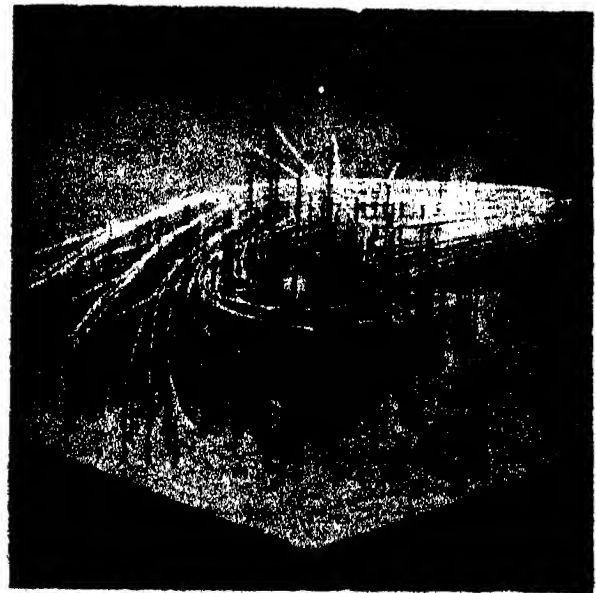


FIG. 4.

Model of trajectories of charged corpuscles coming from the sun towards the earth, represented by the sphere at the centre. Trajectories encircling the earth are clearly seen. (After Störmer)

many difficulties. Two of these, which are rather fundamental, may be mentioned. The first is that it is not possible to have a beam consisting of charged particles of one kind only. Such a beam would soon disperse itself due to electro-static repulsion. The theory, however, demands that the beam should consist of particles of one kind only as, otherwise, the particles would suffer too little deflection by the

earth's magnetic field and will not be able to produce the observed auroral effects in the polar regions. The second difficulty is this. It is found that there is a narrow zone round the earth's magnetic pole at an angular distance of about 22° over which the frequency and intensity of magnetic storms and aurorae are greatest. Störmer's theory indeed predicts such a zone of maximum activity but the distance of the zone (from the magnetic pole) calculated from the theory is much smaller than that observed.

Following Störmer's idea but avoiding some of the difficulties, a theory of magnetic storms has recently been attempted by Chapman and Ferraro. They have tried to show that even if the beam of charged particles emanated from the sun be neutral, *i.e.*, composed of equal numbers of positive and negative charges, it may, while still at a large distance from the earth, develop into a ring of current and produce some of the observed features of magnetic storms. The authors have however left the theory in a more or less qualitative stage.

MAGNETIC STORMS AND SUNSPOTS

A curious fact noticed about the magnetic storms is that they are more frequent and occur with greater intensity when sunspots are numerous. In fact, the intensity and frequency of magnetic storms wax and wane over a period of 11 years following a similar waxing and waning of sunspot numbers. Sunspots are known to be gigantic whirlpools on the surface of the sun and it is sometimes thought that the sunspots eject fast electrified particles in copious numbers and that the magnetic storms are caused by the encounter of these particles with the earth. Close observations have shown, however, that there is no one-to-one correspondence between the two. That is, a particular group of sunspots cannot be associated with a particular magnetic storm. The only relation which has been proved to exist is, as said just now, that a general increase of one is followed by a similar increase of the other.

The reason of the dislocation of telegraph, telephone and radio traffics during magnetic storms is

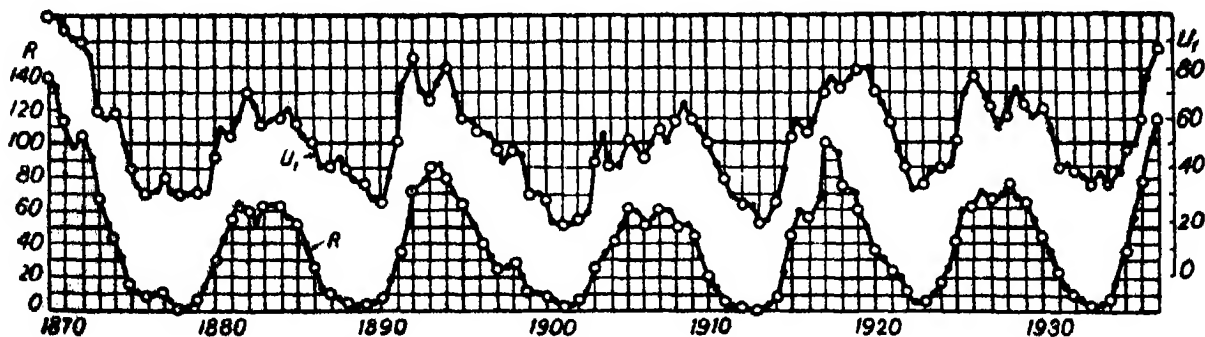


FIG. 5.

Variations of annual mean terrestrial magnetic activity (upper curve U_1) and relative sunspot numbers (lower curve R). The parallelism of the two curves over a period of more than 60 years is striking.

Of late, two American scientists, Hulburt and Maris, have put forward a new theory which also assumes that magnetic storms and aurorae are caused by the bombardment of the upper atmosphere by charged corpuscles. The novelty of the theory lies in the fact that the charged particles are supposed to come not from the sun but from the earth's atmosphere where they are produced by the action of occasional outbursts of ultra-violet radiation from the sun. The authors have worked out the details of the theory but it cannot be said that the explanations offered are satisfactory.

easy to understand. The sudden changes in the magnetic field of the earth (Fig. 3) induces unwanted currents in the network of telegraph and telephone lines and disturbs the message carrying currents. Again, the electrified particles impinging on the high atmosphere during a magnetic storm produces erratic changes in the conducting properties of the 'radio-roof' of the atmosphere and interferes with the regular propagation of wireless waves.

* * * * *

I am afraid I have raised more problems than I have answered. The fact is that scientists are still

ignorant about most of the phenomena connected with terrestrial magnetism. They do not know what is the cause of the earth's magnetism. They do not know the cause of the slow variation of the earth's magnetism due to which the magnetic needle is changing its direction from year to year. They have not yet discovered the exact mechanism of a magnetic storm in all its details. One has to admit that the 'magnetician' is still in the dark about all these things. Nevertheless, to do him justice, it should be said that he is not sitting idle. He is making systematic studies, collecting data patiently and laboriously all over the world and hopes some day to give satisfactory replies to most of these questions. In this connection I must refer to the admirable work which is being carried on by the Carnegie Institution of Washington. This Institution, as its name implies, owes its origin to the munificence of that

prince of benefactors, Andrew Carnegie. Some years ago the Institution built a non-magnetic ship called "*Carnegie*" for making magnetic observations at remote, unfrequented places of the earth. Unfortunately the ship was lost by fire in 1928. The British Admiralty then undertook the construction of a similar vessel called "*Research*" which was to have taken to sea last year. I don't know if the plan failed to mature on account of the war. The Swedish Government which, like the Norwegian one, is keenly interested in investigations on auroral phenomena and magnetic storms built and put to sea a non-magnetic vessel called "*Compass*" in 1937. The vessel had begun making very important observations, but I am afraid its work has been stopped on account of the war.*

* Adapted from a lecture delivered at the Rotary Club of Calcutta.

THE NOISIEST NOISE

Ever since the "invention" of the decibel—the unit of noise—scientists have been measuring various noises to ascertain which is the most ear-shattering. Curiously enough the human ear is not always a sound judge of noise.

Top rank in the hierarchy of noises is jointly shared by the crash of artificial lightning and the blast of a locomotive whistle, each of which registered 125 decibels. The roar of an African lion measured at a distance of two feet scored 115 decibels. This figure was also achieved by a sea-lion and surprisingly, a cockatoo. The bellowing of a prize bull at the same distance and the trumpeting of an elephant notched up 110 decibels.

The loudest human noise was achieved by a professional barker whose leather lungs pushed the needle over to 105. A band of girl pipers blowing their bagpipes for all they were worth recorded the score of 97 decibels.

—The Statesman

Prehistoric Researches in Mayurbhanj

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INTRODUCTION

MANY of the Orissan States are inhabited by tribes who are among the poorest, the most neglected and backward people in the whole of India. These tribes live in the hills and jungles which lie west of the narrow coastal plain. Anthropologists have consequently regarded Orissa as one of the most promising fields of scientific investigation. But, up till now, Orissa has not been a favourite haunt of prehistorians as Madras or the Punjab happen to be. Very few stone implements have been discovered here, and they are not enough to build up a connected account of the ancient history of the land.

In 1876, V. Ball published an account of four palaeolithic implements, he had found in Angul, Talcher, Dhenkanal and Sambalpur. Later on R. D. Banerji (1930) reported a few neolithic tools from Mayurbhanj, which had been discovered by Mr Paramananda Acharya, the Archaeologist of the State. These were all. So, it was with a great deal of surprise and joy that we welcomed the following communication from Mr Acharya from Mayurbhanj: "three palaeolithic sites have been discovered the other day when Mr Worman of Harvard University came here." The letter was dated the 30th of March, 1939; and the story of the discovery was like this.

The Archaeological Department of Mayurbhanj had been interesting itself in Stone Age antiquities for some time, and had already invited the Anthropological Department of Calcutta University in December, 1938 to examine the neolithic site at Baidipur. Later on, in March, Mr Eugene C. Worman (Jr), a research fellow of Harvard University, paid a visit to Mayurbhanj.* Mr Acharya took

him over to see some of the tanks which had been dug in laterite, as Mr Worman wanted to see some sections of laterite beds. One of these tanks happened to be in the village of Kuliana; and, fortunately, the two archaeologists made a precious collection of 22 palaeoliths from this tank. Worman and Acharya also found more palaeolithic sites at Kuchai, Ambasikra and Baripada in course of the same week. The Mayurbhanj State then very generously invited Calcutta University once more to conduct the work of prehistoric exploration; and the present paper is a brief review of the work that the University has done in the village of Kuliana and its neighbourhood during the last season.

The village lies in Lat. $22^{\circ}4'$, $86^{\circ}39'E$, between ten and eleven miles, roughly N.W. of Baripada town (Survey of India map No. 73 J-12). It is quarter of a mile to the east of the main road which runs from Baripada to Chaibassa, and can therefore be very easily reached by motor car. It can also be reached from Buramara railway station on the Mayurbhanj Railway, which is 3 miles away by a good road. The Burhabalanga river flows nearly half a mile west of the village of Kuliana. There is an inspection bungalow, a police station, Tahsildar's office and a post office in the village; so that visitors find the place convenient from all points of view.

GEOGRAPHY AND GEOLOGY OF THE AREA

The river Burhabalanga runs in the neighbourhood roughly from north to south. Immediately near its right bank are low ridges covered by jungle. The left bank is more open, covered by alluvium for some distance, and then by laterite farther away. Beyond the laterite plateaus, which are not always continuous but lie in extensive patches, are a

* He went there and also to the Chakradharpore neolithic site at the suggestion of Mr D. Sen of Calcutta University, to whom he communicated the news of the discovery by a letter dated Chakradharpore, March 25, 1939.

number of low ridges at a distance of between 2 and 3 miles from the river-bed. The valley between the eastern and western ridges is roughly 4 to 5 miles wide near Kuliana. As we have said, the river flows nearer the western ridges skirting the valley.

The country rock is Archæan in age. Its beds dip at angles between 38° and 45° towards E. by N. and E. N. E. The river flows strictly along the strike of the beds between Brahmangaon and Kamata. Beyond Bara Nuagaon in the south, it enters alluvial country, where the course is altered. On the right bank and away to the west, the hillocks in Pariakoli, Bhatuabera and in the neighbouring village of Bhadua are of quartzose talc-schist and quartz-phyllite. The river-bed near Kuliana seems to be of quartzite. On the left or eastern bank, the Archæan rocks are covered for some distance by sheets of alluvium. Hillocks of harder rock however stand out through the alluvium at Kamata and Pratappur; and these are quartzite and sheared conglomerates in quartzose matrix. The latter has approximately the same dip and strike as the quartzite beds. Farther away to the east, there is an isolated hill of quartzite in Chheliadungri near Tikaitpur. Beyond it, several sections have been exposed in cuttings along the railway line. At Nuaberi and some portions of Tikaitpur, the rock is mica-schist, which has become highly weathered. To the N. W. of this, the rock gives place to mica-phyllite near Koilisuta. Occasional outcrops of granite-gneiss occur at Sunsungaria near Tikaitpur; and it appears that the expanse of this rock increases as we proceed northwards along the railway line. In many places beside the railway line, dykes of dark dolerite cut across the country. These have weathered into rounded blocks, the surface of many of which is, more or less, completely lateritized. Obviously the dykes are much younger than the metamorphic rocks through which they have cut their way.

The special point in describing these rocks which lie on both sides of the river, consists in this that these Archæan rocks have yielded the detrital laterite in which the stone implements are found embedded in Kuliana. We observed at Nuaberi and Tikaitpur, that the mica-schists had often been completely decomposed giving rise to primary laterite. Where the weathering has not been complete, the transition from schist to laterite can be clearly observed. Many of the quartz veins which intersected the mica-schist, now stand out as veins within

the primary laterite, for they have withstood chemical decomposition. Where the schists were rich in ferruginous material, the iron has often been segregated in the shape of small tile-like concretions of limonite, disposed in wavy, but roughly parallel horizontal bands. These primary laterites occur not only in the ridges to the east of the river, but also to the west, as at Bhatuabera and, apparently, also near Kathruma.

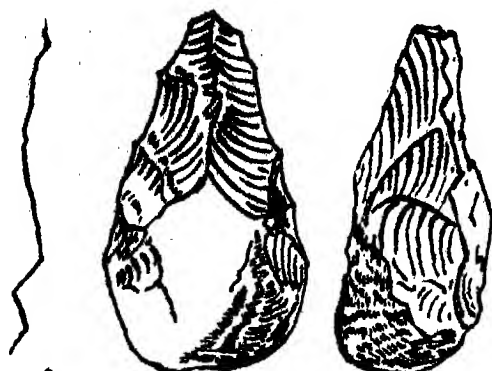
The laterite plain on which the village of Kuliana stands, is however of a different nature. The weathered rocks to the east were washed down by rainwater and small streams, flowing from the hills, towards the bed of the Burhabalanga. The numerous blocks of quartzite, derived either from veins in mica-schist or from the quartzite beds themselves, were rolled and smoothened and then deposited in the form of boulder beds. As the hills were gradually worn down, the torrents must have become slower. The deposits they carried downstream, must have accumulated in the meanwhile, and thus appreciably reduced the gradient of the stream-beds. Due to these two causes, the boulders were gradually replaced by pebbles, and these by gravels higher up. All these, however, were fixed in a matrix of clay. The clay was ferruginous, and subsequently became more or less completely lateritized. In the conglomerate and gravel beds, we find that the matrix is very compact in the deeper layers, while it is more friable higher up. Down below, the matrix shows the typical vermicular structure. The uppermost layers are pisolitic in structure.

It is this alluvial deposit, laid probably by transverse streams flowing down from the eastern hills and not by the Burhabalanga itself, which has given rise to the barren plains in the neighbourhood of Kuliana.

PREHISTORIC FINDS

As we have said already, it is in the lateritized boulder and gravel beds that the stone implements have been found. There are several quarries in the neighbourhood of Kuliana from where gravel has been extracted by the Public Works Department. Four tanks have also been dug in these beds in Kuliana village. And it was in one of these tanks that Worman and Acharya first made their collection of palæoliths in March, 1939. In April of the

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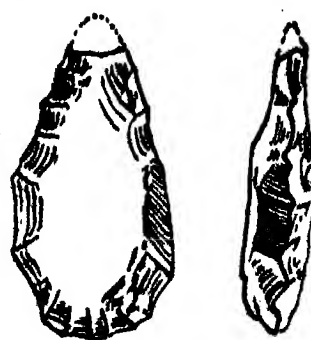


Flake form handaxe
with pebble butt.

L. 12.2 cm. B. 7.5 T. 4.5 cm

MKB
9.7.1940.

Ks-54-3



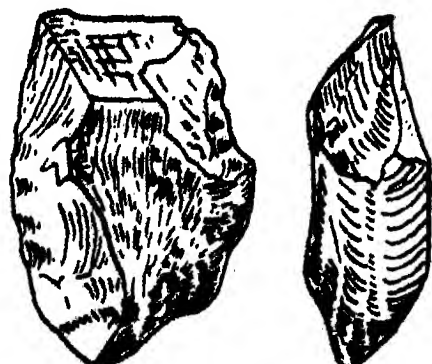
L. 12.4 cm. B. 7.4 cm. T. 2.8 cm



Thin bifacial worked butt.

M. K. B.
10.10.40.

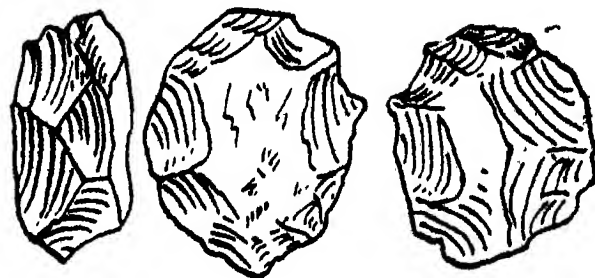
Ku-C-2



cleaver-like pebble tool.

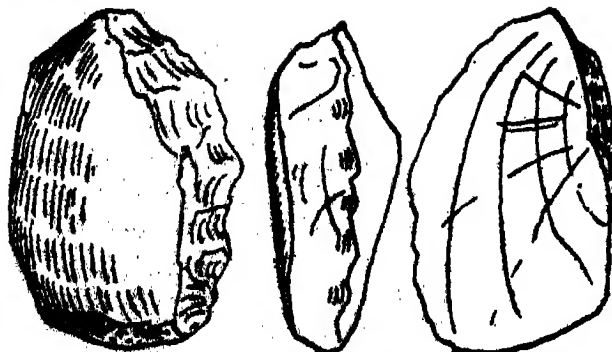
L. 11.0 cm. B. 8.0 cm T. 4.6

Ku-C-3



Discoid tool on core L. 9.0 cm. B. 7.0 cm. T. 5.7 cm.

Ku-57-11

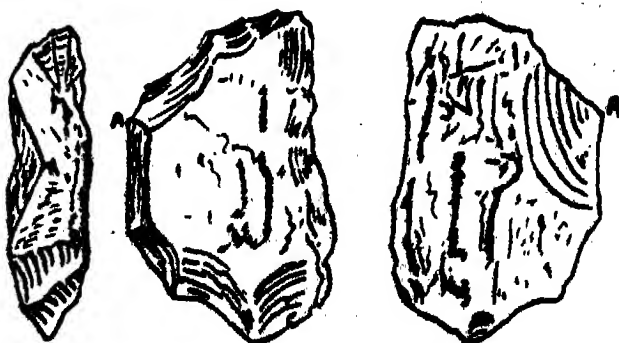


Side-scraper on
flake

L. 13.4 cm B. 8.9 cm T. 5.1 cm

MKB
20.4.40.

Ku-C-22



Side-scraper

L. 10.3 cm B. 6.8 cm T. 2.6 cm

M. K. B.
10.10.40.

DIFFERENT TYPES OF TOOLS FROM KULIANA, MAYURBHANJ.

same year, the Calcutta University party discovered a few more tools in the same place, as well as a fresh site in Koilisuta village, 2 miles to the N. E. The University party once more encamped there for six weeks in December and January, 1940, and discovered numerous very rich gravel quarries in other parts of Kuliana, as well as in the neighbouring villages of Kalabaria (1½ m. N.), Nuaberi (2 m. E.S.E.), Buramara (3 m. N. by E.) and in a field lying between Sandim and Kendudiha (1½ m. N. by E.). Numerous exposures of laterite were examined, and a total collection of nearly seven hundred palaeolithic implements made. The area covered was a little over ten square miles.

Nine trenches were also dug at different localities within Kuliana, one of which ran to a depth of thirteen feet. In the course of these excavations, nearly forty artifacts were unearthed, some of which are implements and some merely waste flakes. Most of the implements occurred between 2½ and 4 feet from the surface of the ground. Only one or two came from a depth of nearly ten feet; and they are of crude form and turned out by deep, heavy flaking. The upper tools are generally of a more regular form, more carefully chipped and better finished. Only three neoliths of the ground and polished variety have been discovered in the thin clay cap which covers the laterite bed in places.

TYPES OF IMPLEMENTS

The work of classification and description of the stone implements is proceeding at the present moment; but from what has already been done, we may say that the tools roughly belong to the following families.

A. Pebble Tools—

- (i) Flat-bottomed with high midrib,
- (ii) Resembling crude, pointed hand-axes,
- (iii) Resembling cleavers,
- (iv) Choppers, margin partially or completely trimmed,
- (v) Pointed, like awls,
- (vi) Ovate forms.

B. Core tools, both faces worked—

- (i) Peariform and sharply pointed triangular forms,

- (ii) Almond shaped, with (a) worked and (b) unworked butts,
- (iii) Discs and choppers,
- (iv) Ovate, i.e., with convex cutting edges, (a) worked and (b) unworked butts,
- (v) Cleaver with transverse cutting edge, (a) pointed butt, (b) square butt,
- (vi) Cleaver with convex cutting edge,
- (vii) Cleaver with oblique cutting edge,
- (viii) A new type of cleaver-like tool with lateral margins alternately chipped to yield working edges, anterior blunt,
- (ix) Side-scrapers with both faces worked all over,

C. Flake tools (one side unworked)—

- (i) Cleaver on flake, transverse, convex and oblique edged,
- (ii) Chopper on flake,
- (iii) Tool with serrated margin produced by one-sided flaking,
- (iv) Scrapers, with unprepared striking platform (none is with prepared striking platform).

D. Cores—

- (i) Used only as a source of flakes.

All the above tools are of quartzite, ranging from a comparatively easily weathered siliceous sandstone to crystalline varieties and flaggy or chert-like specimens. Many implements, even when found on the surface in the neighbourhood of gravel pits, show ferruginous (lateritic) incrustations on their surface or in the angles between flake-surfaces, proving that they must have been dug up from within the lateritized gravel beds.

The neoliths found at Kuliana and Pratappur are of some dark greenish rock like diorite. None of them is of the shouldered type discovered by Mr Acharya in several parts of the State. They are however ground and polished. One of them has a pointed poll and square sides.

USES OF THE IMPLEMENTS

The implements which have thus been discovered either lying within gravel-pits or dug up in

course of the excavation, are of a great range of variety. They are mostly cutting, piercing or scraping tools; and we can imagine that the prehistoric inhabitants of Mayurbhanj lived mostly by hunting. The scrapers however are few, so that the other tools were perhaps not always used in hunting; a body of pure hunters would probably have needed more scrapers. Menghin has suggested that the so-called pointed hand-axes were perhaps used in digging up roots and tubers, rather than for cutting meat or in killing animals. In order to test whether the pointed hand-axes are of any use in digging, we interviewed, one day, a number of Kharia tribesmen, who still gather a large part of their daily meal by means of digging in the neighbouring jungles. The Kharias told us how they have often to go down as much as a man's height or more in order to reach certain varieties of tubers. When shown the hand-axes, they said it would not be possible to dig so deep by means of these tools, as their iron implements themselves become rapidly blunted in course of their work. According to them, the soil often contains broken blocks of hard stone, and the tip of these stone implements would surely break if used in the manner of their own digging sticks.

So the use of these hand-axes remains obscure. We tried another experiment one day, with a crudely flaked chopper on pebble and a fine transverse-edged cleaver. We tried to cut down green branches of trees. One bough was a little over an inch in diameter, and it took us nearly five minutes to cut clean through it. The tool worked like a very blunt axe, with little weight behind. This was, of course, done without hafting, merely by the hand.

Anyway, our experiments did not carry us very far, and we remained where we were. We can, therefore, only repeat here the opinion of European archaeologists that, the men of the Old Stone Age

lived mainly by hunting, supplementing their food by gathering edibles from the jungle. The tools may also have been used in working wood, as the Australians do.

THE AGE OF THE FINDS

Nothing has so far been said regarding the geological age of the finds or of the laterite beds in which they are contained. Unfortunately, the laterite beds in Mayurbhanj have so far not yielded even one fossil. They however overlie, by a considerable height, certain fossiliferous calcareous clay beds near Baripada, which are known to be of middle Miocene age.

The thickness of the laterite beds is variable. It is from two feet to more than thirteen in places. When we failed to obtain any fossil, we sampled the laterite from different depths and tried to find out if the whole bed could be broken up into subdivisions, differentiated from one another by their heavy mineral content. Unfortunately this too did not work. For the only mineral which was thus found was haematite, and it is common to all the layers.

Towards the end of our work, last season, we came across sections in the river bank, a few miles away from Kuliana, where some stratigraphic data are available with regard to the position of calcareous clay, conglomerate and lateritic gravels. When these are examined more thoroughly, and if we are lucky enough, we may be in a position in future to say something more definite regarding the age of the laterite beds. But now, we can say nothing more than this, that the beds are post-Miocene; and much nearer our own time than earlier, because in sections of thirteen-foot depth, the tools occur mostly in the top two to four feet. And, we know, that is not saying very much.*

* Read at a meeting of the Anthropological Society, Calcutta University on July 24, 1940.

The Late Professor Alfred Fowler, F.R.S.

WE regret to report the death of Professor Alfred Fowler, F.R.S., for many years professor of astrophysics in the Imperial College of Science and Technology, South Kensington, London and since 1923 Yarrow Research Professor of the Royal Society, which sad event took place in London on the 10th of May in his 72nd year.

Professor Fowler was, by common consent, the foremost spectroscopist of England, if not of the whole world, and his death will be regretted by international scientific circles. Particularly in this country many of his Indian friends and students have suffered a personal loss, for many of the Indian physicists had their research training under him. Amongst them may be mentioned Professor S. Datta of the Presidency College, Calcutta, Dr K. R. Rao of Andhra University, Dr W. M. Vaidya of Rangoon University, Drs K. C. Majumder, B. N. Bhaduri, J. S. Badami, A. Bose, and Mr M. A. Khan and Miss John. The writer of this note spent some time at his laboratory in 1922 and he remembers with gratitude the great help which he received from Professor Fowler in writing out his theories of solar and stellar spectra.

Fowler started his scientific life in 1886 as assistant to Sir Norman Lockyer in the Solar Physics Laboratory founded by the latter at South Kensington, London. He took part in many solar eclipse observations organised by the Royal Astronomical Society with a view to photographing the spectrum of the solar chromosphere and finding out their interpretation. Through association with Sir Norman Lockyer, he became familiar with the latter's hypothesis of Evolution of Stars in an ascending and descending series and the hypothesis of proto-elements.

While Lockyer was speculating on the probability of evolution of elements running parallel to that of stars, Fowler's attention was drawn to the more important task of finding out the lines ascribed to these proto-elements in the laboratory. He showed that the lines of successive stages of silicon which were used by Lockyer in his evolutionary

scheme, could be produced successfully in the laboratory when increasingly larger stimulus in the form of electrical discharge is used. Fowler's name will be always associated with the successful classification of spectral lines of many elements which he brought to completion. The importance of these works on which modern theories of electron-composition of atoms are chiefly based is not very often realized. When he started work, spectroscopy was in a rather discredited condition. Of course, discovery of spectral analysis had made scientific men familiar with the idea that every atom emits a characteristic spectrum by means of which it can be recognised just as a man is known by his voice, or a musical instrument by the note it produces. But further hope that a knowledge of these spectral lines of atoms would lead us to an understanding of their constitution was not so quickly fulfilled, and the immensity of the data scared away many prospective workers. It was found that even the simplest element gave unusually large number of lines, all coming from the atom, and even six huge volumes of Kayser and Runge were not sufficient to record the full list of lines due to elements. The atom was evidently more complex than any kind of simple resonator which would first come to the mind of a physicist. Iron gives more than 6,000 lines in the visible range, and Rowland remarked that the iron atom was surely a more complicated piece of machinery than even a grand piano. A great physicist like Lord Rayleigh I, whose attention was drawn to spectroscopy excused himself with the remark that he did not wish to get himself engulfed in the bog of spectroscopic data.

It was this unpromising field which was to be the chief centre of Fowler's activity. The discovery of Balmer about regularities in the spectrum of hydrogen, which were further extended by Ritz and Rydberg to alkali elements, attracted new workers to this field, amongst whom the names of Fowler and Paschen stand foremost. Fowler applied their method of analysis to the spectrum of magnesium and other alkaline elements, not only in the first stage of ionisation but also in the higher stages. This work was carried out in a way which he alone was

capable of. He showed that the Rydberg number of the successive stages of ionisation varied as squares of the successive integral numbers.

A brilliant piece of work was done by Fowler in the laboratory when in 1912, just before the appearance of Bohr's fundamental paper on the spectrum of hydrogen, he showed that the stellar lines which were ascribed by Pickering to cosmic hydrogen could be produced in the laboratory when discharge was passed through a tube containing hydrogen and helium, and his researches made it probable that these mysterious lines were due to helium. Bohr definitely ascribed these to ionised helium.

When Bohr's theory of the spectrum of hydrogen first appeared, Fowler was one of the first to appreciate its fundamental nature, but pointed out that the wavelength of the lines of cosmic hydrogen which were identified in the spectra of stars and were ascribed by Bohr to ionised helium, did not agree exactly with the theoretical predictions, but differed by about one Angstrom unit. Bohr promptly replied and showed that the discrepancy was due to the motion of the nucleus which he had neglected in his first approximation. He showed that when this is taken into consideration the wavelength of the lines of ionised helium agreed exactly with those of the stellar lines. No one was more pleased with this reply than Fowler.

It is impossible to give a full account of Fowler's contributions to spectroscopy. He not only did a great amount of work himself but also inspired others to take up this line of work. It was at his laboratory and under his guidance that Catalan, a worker from

Spain, first formulated the idea of multiplets of lines and classified the spectrum of manganese. It is now well known that Catalan's work led to the elucidation of the spectral lines of all complex elements. When Hund's theory of complex spectra first appeared, Fowler was the first to recognise its fundamental importance and popularise it by his writings. He published a large number of papers in collaboration with Lord Rayleigh II on "An active modification of nitrogen" throwing much light, with the aid of his unrivalled knowledge of spectra, on that slippery subject. He had almost an uncanny instinct in recognising the origin of spectral lines, the best known example being the identification of lines of titanium oxide in the spectra of red stars.

Professor Fowler was elected fellow of the Royal Society in 1910. He was awarded Valz prize by the Paris Academy of Sciences in 1913, Gold Medal of the Royal Astronomical Society in 1915, Royal Medal of the Royal Society in 1918 and Henry Draper Gold Medal of the National Academy of Sciences, Washington in 1920. He was awarded the honorary degree of D.Sc. by Bristol University. He was president of the Royal Astronomical Society and General Secretary of the International Astronomical Union for some time.

A large number of Indian students had the good fortune of receiving their training under Prof. Fowler and in the accompanying article Dr W. M. Vaidya, one of his later students, gives an account of his personal reminiscences, during his stay in Fowler's laboratory.

M. N. S.

Professor Fowler : Some Reminiscences

W. M. VAIDYA

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MY long association with Prof. Fowler began with my joining his laboratory as a research student in October, 1929, soon after my graduation from the University of London. Even though I had spent two years in the College as an undergraduate, I had no occasion to know him personally earlier as Prof. Fowler had ceased lecturing to undergraduate students from 1926. So when I was first introduced to him I felt awe-inspired and somewhat nervous because I had never before done research in my life. I, however, soon felt better when I met two other Indian students working in the laboratory. They were Dr K. R. Rao and Dr J. S. Badami.

It was the practice of Prof. Fowler, when putting a new man to research, to give him some simple problem in the beginning so as to initiate the student in the routine of research, that is to say, to train him in finding out literature, looking up references, and to habituate him to the use of different spectroscopic instruments. In this preliminary period, I was asked to test whether a newly suggested formula for the calculation of wavelengths was sufficiently accurate as the old one. My main problem came soon after, when I was directed to explore the possibilities of utilising photographic methods in the extension of infra-red spectra. I spent some six months on measuring the accuracy of the new formula without any prospects of success and one day Prof. Fowler said, 'It does not seem exciting, you better take another new problem'. And now was to commence the new problem which has proved to be of great interest, namely, the application of spectroscopic methods to the study of chemical reactions in flames.

The flame which I started with was that of carbon disulphide. In this connection, he used to compare my plates with those of his own which he

had taken in 1886, just when he had started his research career some 40 years ago. This wide experience was one of his greatest merits because what at times looked like insurmountable difficulties could be correlated by him, in virtue of his experience, to deduce some important result.

In this research I came in greater intimate contact with him. I was asked to see him as often as possible and was required to show him every spectrum plate that I took, whether spoilt or otherwise. His reception used to be extremely cordial and in my long association I never found him even once in a wary mood. He was always kind and considerate. Once, while examining the phosphorescent flame of carbon disulphide there was an explosion and my clothes caught fire. After that, even the slightest noise frightened me, so Prof. Fowler gave me leave for a week and said, "you better get your nerves steady a bit."

I can give a number of striking instances of his keen powers of observations. Spectrum plates on which we could notice nothing extraordinary conveyed a lot to him. I was examining the spectrum of sulphur in a discharge tube; there was a slight impurity of nitrogen which brought out the spectrum of nitrogen sulphide. This spectrum was closely similar to that of the well-known bands of NO and yet had escaped my attention but Prof. Fowler immediately noticed the existence of a new band system which was later given for detailed investigation to Dr C. J. S. Bakker, a student of Prof. Zeeman from Amsterdam.

Again, when I was studying the flame of carbon tetrachloride, an extensive band system came out and its nature puzzled him a lot. In one afternoon he measured all the bands, completed the vibrational

analysis and came to the conclusion that the separations were of the same order as the sulphur bands. The question was what could be the source of sulphur in the flame. It was traced to the connecting rubber tubing.

His advice to new comers used to be "Identify every thing on the plate." This used to be at times very irksome because it was not always possible for us to identify every thing without detailed measurements. But with him it used to be so easy. On one plate of the carbon disulphide flame, a strong line appeared, the nature of which seemed unknown. He immediately spotted it as that of barium and in order to confirm the identification he asked me to find out if anybody was taking barium spectrum. His guess proved to be absolutely true when I found that one student was actually taking the barium spectrum while working near me. Barium vapour had contaminated the carbon disulphide flame.

He was a hard task master without being harsh and would always see that the students did their allotted work properly. At times he would give an experiment late in the afternoon and would ask for the plate next morning. Any one thinking that it was too late to work in the day would at once be caught. I remember once a lady research student was asked to take the spectrum of the nitrogen discharge tube on a Thursday afternoon. On Monday she was asked about the plate, but she said, "I spent the week-end with some of my friends and so I could not take the spectrum." Prof. Fowler's reply was, "Students who want week-ends have no room in my laboratory." He often used to catch us like this by coming in the laboratory late on Friday afternoon, because every one thought that their going away early on Fridays would not be noticed. Once finding that the senior demonstrator was not there on a Friday afternoon, he remarked, "That is taking life very easy."

With many professors, when guiding research, it is a habit to give problem to a student in the beginning and then hand him over to senior research assistants, so that there is very little intimate contact between the professor and the student. But with Prof. Fowler it was different. He insisted that his students should go and see him as often as possible. In the morning his room used to be full with all of us reporting the progress of our individual research. This gave me splendid opportunity of watching the

working of a great mind because often he had 8-10 different research students being guided at the same time. By keeping direct contact with the students and again by insisting on showing to him personally every spectrum plate taken, howsoever apparently insignificant, it was made absolutely certain that no important results went without being noticed. An instance of this was the identification of the ethylene flame bands. These bands had been mentioned by others and they even occur in most common flames such as the Bunsen flame, ether, etc., but no details were available. But Prof. Fowler noticed them appearing with increased intensity on the plate of ethylene. When he saw this spectrum, his face became very grave and then looked extremely engrossed. He asked me to leave the plate with him for further examination. He measured the bands, got out a vibrational analysis, but seemed more puzzled, because the measurements even could not fix the nature of the bands. All the band systems associated with carbon and hydrocarbons he knew very well, so at last he came to the conclusion that in the ethylene flame there was something new. He got immensely interested in finding out the source of these bands and studying their properties. Now my relationship with him became still more intimate. Morning and afternoon I used to be with him discussing the nature of these bands. Feeling that his knowledge of hydrocarbon chemistry was not sufficient, he told me that he had begun reading a book on organic chemistry at that age. Even though he held such an eminent place, he did not feel it below his dignity to discuss the problem with anybody much lower than himself if he thought the person might be able to increase his knowledge in a certain direction.

I can quote more instances of his powers of observation. A research student was trying to get a band system corresponding to HCl and was therefore experimenting with discharge through HCl vapour. In the spectrum was observed a strong band in the ultra-violet, which could not, however be immediately identified. But soon Prof. Fowler established that the band was that of aluminium chloride on which Dr Jevons had previously worked in his laboratory. It was this wide experience which used to be of such immense help in the solution of difficult problems. Similarly, when I was working with the ethylene flame I obtained a plate of the spectrum of ethylene flame with hydrogen blown through, on a very small Hilger spectrograph. This

spectrum was extremely faint and vertical height was just about a millimetre. Not much could, therefore, be seen on the plate, but Prof. Fowler noticed something extraordinary, got very excited and said, "What made you expose this flame? It gives additional ethylene flame bands."

Prof. Fowler was always fond of Indian students. He expressed this to me in personal conversations and also through correspondence. To my knowledge no Indian student was ever refused admission in his laboratory. As mentioned before, when I first joined, Dr K. R. Rao and Dr J. S. Badami were already working under him. When they left in the summer of 1931, Dr K. C. Mazumdar, now the manager of the Bengal Electric Lamp Works Ltd. and myself were together. Towards the end of 1931, Dr Bhaduri joined us and we three continued till 1934; Dr Mazumdar got his degree in January 1934, Dr. Bhaduri in March 1934 and myself in June 1934. For a short while Mr M. A. Khan, who is now a lecturer in physics in Osmania University came as a research student but soon left. So also Miss John worked for a little while in the summer of 1933 but on being appointed as a lecturer in Women's College in Travancore, she discontinued.

On my last day in his laboratory in June 1934, when I went to his room to bid him goodbye, he said, "Well, I am glad that you listened to me and stuck to your job and made a success of it. These University

regulations only annoy me. I like to see students doing research for its own sake and work till they obtain some important results. I want them to be in a position to stand on their own legs and be able to start research on their own wherever they go." I had the honour of meeting him again in the summer of 1939. He was immensely pleased and made kind inquiries of all his Indian students.

Prof. Fowler's name will always be associated with accuracy and thoroughness. He used to be extremely painstaking with the measurements and no results were ever allowed to be published till he satisfied himself about their accuracy. Neither would he communicate any paper without convincing himself that the subject matter was verified a number of times. This seemed such a slow process to us but he always used to say, "Do not be in a hurry, it takes a long time to build up good reputation." In his laboratory the spectrum plates taken by all the students were stored, neatly labelled and classified. Seeing that Prof. Fowler did active research for nearly fifty years, one can realise what a fine collection of spectrum plates there was in the laboratory for reference.

In Prof. Fowler we have lost an eminent spectroscopist, a great teacher, and a kind gentleman. Those of us who had the fortune of knowing him personally and also those who knew him through publications will ever mourn his loss.

The Rôle of Growth Hormones in the Production of Seedless Fruits

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FERTILISATION initiates profound changes in the flower. The ovules are transformed into seeds and the ovary may increase thousand times the size it had before fertilisation. The difference is easily appreciated by measuring the pistil of a water-melon or a pumpkin or a coconut just before fertilisation and after it has ripened into a full-grown fruit.

When fertilisation fails to occur, the flower withers away and falls off due to the formation of an absciss layer at some point in the pedicel. There are however exceptions. In certain cases fruits may be formed without fertilisation or even pollination. This is well known in certain varieties of grapes, oranges, cucumbers, papayas, pineapples, mulberries, figs and bananas. Fruits formed in this manner are generally seedless (parthenocarpic),* because the ovules fail to develop due to lack of fertilisation. Horticulturists encourage the appearance of seedless varieties because of the ever-increasing public demand for more juicy fruits which can be eaten more comfortably without having to reject the unwanted seeds. Bananas containing seeds would not find a market and seedless grapes are held in higher price than those with seeds. On the other hand, there are also plants in which seedlessness would be of no special advantage. Thus, in the case of mangoes and jujubes, the offending substance is the endocarp and not the seed, and a seedless variety would not be superior to the ordinary one just because of this character.

* It is necessary here to point out the difference between seedlessness and parthenocarpy. The former is a purely descriptive term used for any fruit that is devoid of seeds, whatever may be the cause of this condition. Parthenocarpy, on the other hand, refers to the formation of fruits without fertilisation or even without pollination. Such fruits are usually seedless or have abortive seeds incapable of germination, but in very rare cases seeds may be produced in them owing to a parthenogenetic development of the egg.

Seedlessness in fruits may result from (i) parthenocarpy, or (ii) embryo abortion after fertilisation, caused by some external or internal influence.

In this article we shall concern ourselves only with parthenocarpic seedlessness.

HISTORY

A beginning into artificial parthenocarpy was made as early as 1849, when during the course of his hybridization experiments Gaertner obtained some fully ripe but seedless fruits of certain cucurbits by pollinating their stigmas with the spores of *Lycopodium*. Millardet (1901) induced fruit formation in certain varieties of the European grape by employing pollen of *Ampelopsis hederacea*, and a partial development of the ovary in certain cucurbits by 'pollinating' the stigmas with powdered pollen. Fertilisation was obviously impossible in these cases and the fruits were therefore parthenocarpic. Similarly Massart (1902) placed dead pollen upon the stigma of an orchid and observed a slight increase in the size of the ovary. Fitting (1909) made a further advance by making the ovary wall swell not only through the use of dead or foreign pollen but also by painting the stigma with an extract of pollen. Further experiments of a similar nature were made by some later authors leading to the conclusion that pollen has a definite influence on the growth of the ovarian tissues, which is independent of fertilisation or maturation of seeds. The work, done during the last decade, and which is reviewed here in some detail, shows that this influence is of a chemical nature. Indeed, some workers in Germany and America have successfully produced parthenocarpic fruits by treating the ovaries with known chemical substances or "growth hormones".

METHODS FOR INDUCING PARTHENOCAIRPY

The methods used for promoting growth in the ovary without fertilisation fall into 3 main categories :

(1) *Mechanical stimulus*, including castration, pin-pricks, contusions etc., which occasionally induce the cells to grow to some extent.

(2) *Artificial pollination* with pollen of the same or another plant, designed in such a way as to preclude the possibility of an actual union of the male and female gametes.

(3) *Chemical treatment* by means of auxins or other organic compounds.

MECHANICAL STIMULUS

As regards the first method, it may be stated that parthenocarpic growth is caused only rarely by physical stimulus alone. A well-known example is that of *Prunus padus*, where the ovaries give rise to empty fruits called "bladder plums" or "plum pockets" because of the effect of the fungus *Taphrina pruni*. The presence of insect stings inside the ovary wall is also known to stimulate its growth in some cases. Ovaries of certain orchids can be made to grow by a mechanical irritation of the stigmas. Occasional instances are to be found in literature of ovaries having been induced to grow by cutting away the tops of flower-buds and by the infliction of pin-pricks or other slight mechanical injuries. The results are however very conflicting and generally the injury proves fatal.

POLLINATION WITHOUT FERTILISATION

The second method *i.e.*, pollination designed in such a way as to allow the pollen tubes to grow into the ovary while preventing an actual union of the male and female elements, has received much attention at the hands of the Japanese botanist Yasuda. He recalls (1939, p. 6) an incident of his boyhood which led him on to this work. While his father and a friend were once discussing in his presence the subject of the fruiting habits of the squash, mention was made of the fact that the first female flower of this plant opened earlier than the male and dropped off without producing any fruit because fertilisation had not been possible. But the friend knew a "wonderful magic" for overcoming the difficulty; he would pollinate this flower with the pollen of the bindweed (*Calystegia* sp.) and in this way many fruits would be produced which were of nearly normal size. When the boy grew up and became a botanist, he put the statement of his father's friend to a test and found that he was right, the fruits produced having no viable seeds whatsoever. The pollen of *Calystegia* had proved adequate for stimulating

growth in the ovary but the incompatibility between the two genera prevented an actual fertilisation of the ovules.

Further experiments made by the same author during a period of several years (mainly on members of the Solanaceae and Cucurbitaceae) showed that it was possible to induce the formation of parthenocarpic fruits by several methods, as enumerated below, which are more or less similar to the above in principle. It is of course admitted that all plants do not react favourably to these experimentations.

(a) The flowers were castrated and pollinated with pollen of the same species in different stages of maturity. As was to be expected, with mature and viable pollen the ovaries developed into normal fruits, but even immature or overmature pollen (impotent for purposes of fertilisation) frequently stimulated fruit formation, with the difference that the fruits thus formed were devoid of seeds.

(b) In another lot, the same procedure was adopted using foreign pollen *i.e.*, pollen from another plant belonging to the same or a different family. In this case also only fruits without seeds or with abortive seeds were produced.

(c) To achieve the same result, the styles of a number of egg plants (*Solanum melongena*) were cut off at their junction with the ovary at different intervals after pollination. When the operation was sufficiently delayed, the pollen tubes were able to reach the ovules and fertilisation occurred normally, resulting in fruits with viable seeds. If, on the other hand, the operation was performed at the proper time (*i.e.*, just when the pollen tubes had reached the place below which the cut was to be made), seedless fruits were formed. In the control experiments, in which some of the flowers were left unpollinated but the styles were cut off as before, no fruits were formed at any time.

(d) In still another set of experiments, the styles of egg plants were cut off but regrafted on the ovaries with an intervening layer of gelatine. The materials thus operated upon were divided into two lots, one lot being self-pollinated and the other left unpollinated. The ovaries of the former lot occasionally developed into seedless fruits while the unpollinated ones either failed to grow or in a very few cases produced fruits much smaller than those of the first lot.

(e) Finally, the same author (see also Gustafson, 1937) got satisfactory results by injecting aqueous extracts of pollen into the ovary. Egg plant ovaries injected with pollen extract of *Petunia* grew to a size of 4.1×7.3 cm., and 3 out of 50 cucumber ovaries, injected with cucumber pollen extracts, continued growth, one attaining a size of 4.3×20.3 cm. which compares favourably with the size of a normal cucumber.

As a result of his experiments and microscopic investigations, Yasuda has arrived at the following conclusions:

(1) That pollen tubes secrete or carry some chemical substances ("growth hormones"), which diffuse into the tissues of the ovary and thereby cause fruit formation. This view also receives support from the experiments of Meyer (1936) who finds that in the female flowers of *Cucurbita pepo*, *Cucumis sativus* and *Helianthus annuus* the auxin concentration is appreciably greater just after fertilisation than before it.

(2) That seedless fruits may be formed if the pollen tubes are allowed to penetrate into the ovary up to a safe distance from the ovules so as to admit of chemical diffusion but not fertilisation.

(3) That the same object may be achieved by pollinating the stigmas with immature, overmature or incompatible pollen.

Recently Gustafson (1938) has reported that a kind of partial parthenocarpy can be induced in "Crookneck summer squash" and pumpkin by reducing the stigmatic surface. Varying amounts of the stigmatic surface (in some cases as much as five-sixths) were removed by cutting off some of the lobes; pollination was therefore only one-sided, nevertheless most of the ovaries grew into normal-looking fruits, although as might be expected the number of seeds was very small.

CHEMICAL TREATMENT

The fact that extracts of pollen, like the pollen tubes themselves, could also induce parthenocarpic growth (Laibach, 1932, 1933 and others), left no room for doubt that the stimulation was entirely chemical in nature. Bearing this fact in mind, some American workers, notably Gustafson (1936, 1938a, 1938b) and Gardner and Marth (1937, 1939) tried to determine

whether a chemical treatment could induce the ovary to develop into a fruit without pollination.

Several substances were tried, chiefly indole-3- α -n-propionic acid, indole-butyric acid, indole-acetic acid or heteroauxin, α -naphthalene acetic acid and phenyl-acetic acid. These were made up into a paste with lanolin of about .5 to 1% strength, which was smeared on the stigma. In some cases it was found better to cut off the style just above the ovary and put the paste on the cut surface of the latter; this reduced the distance the chemical would have to diffuse in order to reach the ovary.

The plants for experimentation were mostly selected from the Solanaceae and the Cucurbitaceae because of the facility which they afforded for the removal of the stamens when present. Usually the flowers were subjected to three different kinds of treatment, some being pollinated in the usual way, others treated with the substances under investigation, and the remainder neither pollinated nor handled in any other way. The first lot produced fruits of the normal type and the third gave no fruits at all. As a result of the second treatment, the formation of parthenocarpic fruits could be induced in tomato, pepper (*Capsicum*), egg plant, *Petunia Salpiglossis* and Crookneck squash. No success was, however, achieved with melon, summer and winter squash, and pumpkin (Gustafson, 1936). Hagemann (1937) similarly obtained parthenocarpic fruits of full size in *Gladiolus*, and Wong (1939) in cucumber, water-melon and pepper. Oinoue (1938) used 0.50% heteroauxin and obtained seedless fruits in *Vitis vinifera* and *Solanum melongena*. He notes that parthenocarpy can also be induced in the grape vine by means of oestrone (=folliculin). Further, Schroeder (1938) working with tomato, found that when a lanolin paste of indole-acetic acid (1 in 500) was applied over the entire ovary, the percentage of fruits set compared favourably with normal and hand pollination experiments. The average weight of fruit from the hormone-treated flowers was however not so great. In his experience applications to the stigma or to the end of the ovary after cutting away the style were much less effective.

Gardner and Marth (1937) introduced still another technique. By means of an atomiser they sprayed the ovaries with aqueous solutions of the same substances (naphthalene acetic acid was found to be the most effective) in concentrations ranging

from 0.1 to 0.0001 per cent. *Ilex opaca* (holly) was selected for this purpose because of its dioecious nature on account of which the pistillate flowers require no previous emasculation and can be easily protected from chance pollination; besides, the pistils have a broad stigma seated on an extremely short style, which tends to make the diffusion quicker. Considerable success was attained in getting fruits which were of course seedless. The same treatment gave some positive results with strawberries but none with the apple and the grape.

The proper time for spraying is naturally one of the most important factors essential for success just like the choice of the proper chemical and the concentration in which it is to be used. Flowers sprayed in the bud stage failed to form fruits in *Ilex*, probably because the stimulus cannot easily go through the thick cuticle of the pedicel or other organs. With naphthalene-acetic acid the flowers responded best on being sprayed some days after opening, when the corolla had completely withered and they were themselves ready to fall. Within two days after spraying the pedicels and pistils turned green and began to grow as if by magic.

Two alternative methods were also used with some success: (a) watering the soil around the plants with 15% indole-acetic acid, and (b) introducing small quantities of the dry chemical into holes made into the stem with a small nail.

The injection of these substances into the ovary through the pedicel was also tried and found very effective in some plants like the tobacco, the potassium salt of indole-acetic acid being found more so than the acid. This is attributed at least partly to the fact that the salt is more soluble than the acid, thus permitting its use in somewhat higher concentrations.

More recently still, Zimmerman and Hitchcock (1939) of the Boyce Thompson Research Institute (Yonkers, N.Y.), have pointed out the possibility of a vapour-treatment. It is claimed that fruits were obtained in the holly by the application of vapours of methyl, and ethyl-naphthalene-acetic acid to unopened flower buds. A similar swelling of the ovary and receptacle was obtained in *Fuchsia* and strawberries.

Histological examinations of parthenocarpic fruits and those developing normally after pollination

have also been made and it has been found that they are essentially similar, the only difference being that there is no trace of an embryo in the former (Gardner and Kraus, 1937). The parthenocarpic fruits are also generally a little smaller and lighter than the normal ones, although in *Ilex* they are frequently found to be larger. Gardner and Marth (1939) are of opinion that the application of growth hormones prevents the formation of an absciss layer at the base of the flower pedicel, thus permitting the upward flow of the nutrients necessary for the growth of the fruit and probably acting as a partial substitute for the stimulus set up by the developing fertilised ovules.

CAUSE OF PARTHENO-CARPY

Recently Gustafson (1939a, 1939b) has investigated the auxin content of the ovary in a few species of flowering plants and found that in every case it is higher in the ovaries of parthenocarpic varieties than in non-parthenocarpic ones. From this and other evidence he concludes that the reason why some plants produce fruit parthenocarpically is that the ovaries contain enough auxin to let them start growth without fertilisation, while the ovaries of other plants do not contain a sufficient quantity of this substance in themselves and this has to be augmented by pollination and fertilisation. The same result can however be brought about artificially by external application or injection of the requisite growth hormone.

SUMMARY AND CONCLUSIONS

From the academic standpoint, it has been proved quite decisively that it is possible to produce parthenocarpic fruits by artificial means. Immature or overmature pollen of the same plant or foreign pollen as well as pollen extract can stimulate ovary enlargement. The fruits formed are generally seedless but may occasionally have seeds containing parthenogenetically produced embryos. Parthenocarpic fruits may also be obtained by sprays or vapours or injections or lanolin smears of growth hormones.

The economic possibilities of these methods are obvious, provided cheap and large-scale treatments can be devised. The richness and variety of fruits in the tropics is almost endless and only the fringe

of the problem has been touched. It is clear however that not all plants can be expected to respond to such treatment with equal readiness.*

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The Archaean Complex of Mysore

THE Mysore State has a well-organised Geological Department, staffed with competent geologists, which was organised in 1894. Since its inauguration some of its officers, namely Smeeth, Sampat Iyengar, Jayaram, Rama Rao, Pichamuthu and several others have made notable contributions to Indian geology. A thorough survey of the State which occupies the vast area of about 29,400 sq. miles, much of which is mountainous and the western part of which is occupied by the heavily forested Western Ghats, requires a great deal of careful and painstaking observation. Such work naturally takes much time which a department, whose primary object is the development of the mineral resources of the State, can ill afford. In course of the detailed revisionary examination of selected areas it was found that many of the views held by the older geologists like Smeeth and Sampat Iyengar require revision and re-statement. The results of recent investigations have been summarised in a clear and succinct manner in a recent publication of the Mysore Geological Department in the form of a bulletin entitled "*The Archaean Complex of Mysore*" by B. Rama Rao, Director, Mysore Geological Department. This work traces the development of the latest ideas about the nature and sequence of the rock formations and gives an able exposition of the present state of our knowledge, indicating at the same time the lines of future work. In this work of re-interpretation of the geology of Mysore, the author of this important monograph has played an important part.

The geology of Mysore is apparently very simple, as the entire country consists of a complex of ancient crystalline schists and gneisses with granitic intrusions, all of Archaean age, cut by basic dykes of post Archaean but pre-Cambrian age. But, as in other similar areas of ancient rocks, it is difficult to determine the exact mode of origin and relationships of these rocks. In Mysore the difficulty is all the more great owing to the highly altered nature of some of these rocks and the inaccessible nature of some parts of the terrain. Although exposures of rocks are quite abundant, the forest-clad mountains

and the soil-capped plains have rendered correlation and correct interpretation of the sequence of rock formation difficult. Later more intensive researches have led to wide divergence of views between the older geologists like Smeeth, Sampat Iyengar and Jayaram, and Rama Rao, the present Director.

The most notable revisions suggested by Rama Rao are, (a) the three-fold division of the Dharwars of Mysore, (b) the sedimentary origin of part of the Dharwars, (c) the recognition of the true nature of Champion gneiss and the restriction of its use to certain stocks and bosses of granite-porphyry and the suggestion that it is older than the Upper Dharwars of Mysore and intrusive into the Middle Dharwars, and (d) the hybrid and metamorphic origin of the charnockites of Mysore and the discovery that they do not form a separate granitic intrusion.

These are very important findings and they have been put forward after a great deal of patient and hard work. They clearly set out the main outlines of the Archaean complex of Mysore and prepare the basis for more intensive petrological work and the work of correlation. Any one who has followed the controversy about the origin and classification of these Mysore rocks will realise with what difficulty the above broad facts of Mysore geology have been disentangled from a vast mass of confused ideas and will see that the simplest and the most reasonable explanations are often the most correct. We owe to the Mysore geologists the discovery of the older age of the Dharwars compared to the granites and gneisses, but they had held firmly to the igneous origin of the Dharwars—a view which could not be accepted by the geologists working in other parts of India. Even such rocks as limestones and ferruginous quartzites were considered to be of sedimentary origin due to the replacement of the Champion gneiss, crystalline limestone as the result of the contact alteration of dark hornblende schists of igneous origin, ferruginous quartzites as formed from the breaking down and reconstruction of the amphibolites, quartzites as crushed phases of vein quartz. Conglomerates were considered to be of autoclastic origin, and shales as due to weathering of pre-existing igneous rocks. It is interesting to note that Bruce

* Being a review of a publication of the same name issued by the Director of the Mysore Geological Department.

Foote, who first organised the Mysore Geological Department, thought the Dharwar schists as intensely altered sediments with contemporaneous lava flows and basic intrusions, but following the then prevailing ideas he considered them as elongated synclinal bands resting on the gneissic basement complex. He noted also a case of ripple marking in the quartzites in the valley west of Kaldurga. The earlier field geologists like Slater, Sampat Iyenger and Jayaram, at first believed the Dharwar schists as of sedimentary origin, but later on they all changed their opinion and fell in line with the views of Smeeth that they were of igneous origin.

Rama Rao working from 1918 to 1927 mapped intensively several areas of schist belts and adduced evidences in favour of the sedimentary origin of some of the members of the schist belt, such as, the traces of current bedding in the quartz schists and pillow structure in the basic lavas of Chitaldrug, indicating water action, and the mineralogical nature of some of the schists like the kyanite-graphite-sillimanite granulites. He also found that the dark hornblende schists forming the lower division of the Dharwar of the previous classification were intrusive into the chloritic schists of the upper division, which view was later accepted by Smeeth, and that the basic charnockites occurred as inclusions in the Peninsular gneiss and hence older and are altered facies of pre-existing rocks. By 1935 Rama Rao brought forward indubitable evidences in support of the sedimentary origin of some members of the Dharwar. These are the signs of current bedding and ripple marks in the quartzites, pebbles of current bedded quartzites in the conglomerates of the Shimoga and Chitaldrug schist belts, chemical nature of schists like cordierite sillimanite rocks, etc. Pichamuthu proved the sedimentary origin of the Kaldurga conglomerates and the ferruginous quartzites of the Bababudan area.

The granite gneiss intrusives were classified by Smeeth into four different groups according to their periods of intrusion, namely, Closepet granites, charnockites, Peninsular gneiss, and Champion gneiss. Of these the charnockites are proved to be reconstituted phases of older rocks due to the intrusion of the younger Closepet granite, and the Champion gneiss as marking an earlier period of granitic intrusion. The upper division of the Dharwar in Mysore rests unconformably on the Champion gneiss (granite porphyry) with a basement conglomerate and hence this granite may correspond to the banded gneissic complex of Rajputana, which is older than the Aravalli System of Dharwar age.

Apart from the important contributions to the geology and petrology of the Archaeoan complex, the most noteworthy contribution in the field of petrology is to the problem of the nature and origin of the Charnockite series. Originally described by Sir Thomas Holland as the products of differentiation of a normal plutonic intrusion, their mode of origin has been the subject of controversy, and various suggestions have been made from time to time. Sir Thomas Holland explained the granulitic texture as the result of deformation during the later stages of consolidation. Vredenburg in 1918 suggested that the charnockites of Mysore were formed by the high grade metamorphism of the basic igneous rocks of Dharwar age. Rama Rao has found field evidences and microscopic evidences which show that the charnockites of Mysore are not of primary igneous crystallisation. It seems that the term charnockite was rather loosely used in the earlier survey, for we read that 'the solid zone of charnockites of the range of Biligirirangam hill, on detailed mapping is found to resolve into an interbanded series of granulitic biotite gneiss, stringers of massive norite boulders, and bands of biotite gneissic granite containing hypersthene in variable proportions'. Rama Rao has shown that hypersthene which is one of the characteristic minerals has originated in the 'charnockitic rocks of Mysore' in several ways, e.g., by silification of olivine at the contact of ultrabasic rocks and granite, by assimilation of aluminous sediments by basic intrusives, by paramorphic alteration of cumingtonite and ferrous anthophyllite of the ferruginous quartzites at their contact with the Closepet granite, by incorporation of the hypersthene of norites in granites, by alteration of anthophyllite and gedrite at their contact with basic dykes, and as a constituent of pyroxenite and peridotite xenocrysts in granite-gneiss.

The formation of orthorhombic pyroxene in norite by assimilation of aluminous sediments is well known. In the charnockite of Travancore, Sen Gupta noted the transformation of monoclinic pyroxene into rhombic pyroxene, a fact noted also by Groves in the charnockites and the associated orthogneisses of Uganda and by Chatterjee in the anorthosites of Bengal. Ghosh has suggested a hybrid origin for the hypersthene bearing rocks in Bastar State in the Central Provinces, by the assimilation of a basic diopsidic rock by a highly alkaline magma. Buddington very recently discussed the origin of the charnockite series and has in that connection referred to the view of Lebedev that they

are abnormal igneous rocks formed by the reaction of granitic magma with metagabbro or metadolerite under deep seated conditions.

When Holland proposed the term 'Charnockite Series', he brought forward indisputable evidences of their igneous origin and restricted the use of the name to undoubted igneous rocks showing similar magmatic differentiation, intrusive characters, and consanguinity among the different members. Similar rocks in other parts of the world were mostly considered to be of igneous origin, *e.g.*, the pyroxene granulites of Canada and the charnockites and anorthosites of Norway. In fact Goldschmidt proposed the name Anorthosite-Charnockite stem and Suter Anorthosite-Charnockite province for these rocks. According to Stillwell the charnockites of Adelie Land, Antarctica, owe certain characters to metamorphism and Groves considers that the charnockites of Uganda have suffered plutonic metamorphism. Recently Crookshank has studied the charnockites of southern Jeypur and considers them as normal igneous rocks with subsequent crushing and low grade metamorphism.

It will be seen from the above considerations that the name charnockite has been used to designate rocks of diverse origin which show certain apparent similarity. It seems desirable to establish once for

all certain criteria which should be considered specific for the charnockites and to restrict the use of the term to only those rocks which show these characters. Jayarama thinks that the acicular inclusions in the charnockite quartz as due to the infiltration of titanium solution during the final stages of the consolidation of the magma, which proves the magmatic origin of the charnockites. Mere presence of hypersthene is no criterion. Hypersthene gneisses in which the hypersthene is of metamorphic origin has been found in Uganda, Ranigunj coalfield, Sonthal Parganas, etc. Just as granite may originate by direct magmatic differentiation or by migmatization or granitisation, and as norite may be of primary crystallisation or of hybrid origin, the magma of the charnockites may have originated by more than one process. The apparent similarity of charnockites of different origin is due to their subsequent metamorphic impress. But whether it is desirable to call all such rocks charnockite or only those which show certain specific characters indicative of differentiation of primary magma requires careful consideration of the petrologists working on these and similar rocks.

In the final chapter the author gives an account of the geological history of Mysore which may be briefly shown as follows, based on a table drawn up by the author:—

Archaean ...	{	Pre-Cambrian	11. Basic dykes, chiefly dolerites.
		10. Felsites and porphyry dykes.	
		9. Closepet granites.	
		Formation of the charnockites.	
		8. Norite dykes.	
		7. Hornblende dykes.	
		Peninsular gneiss.	
	{	Upper Dharwar	6. Ferruginous and cherty silts, clays, calcareous silts and clays, impure quartzites and conglomerates.
		{	Middle Dharwar	5. Granite porphyry and granitic rocks.
	4. Basic and ultrabasic intrusives.		
	3. Ironstones, limestones, argillites, quartzites and conglomerates—and ashes, tuffs and other volcanic products.		
	2. Rhyolites, felsites and quartzporphyry and other acid volcanic rocks with opalescent quartz.		
	{	Lower Dharwar	1. Basic volcanic flows and dykes
		Original basement not recognised.	

S. C. Chatterjee.

Notes and News

A 5000-ton Cyclotron

READERS of this journal are probably aware of the cyclotron, the wonderful apparatus invented by Professor E. O. Lawrence of the California University (*Vide* article in *SCIENCE AND CULTURE*, Vol. 5, p. 403, 1940 by D. P. Roy Chaudhuri). The cyclotron is the most efficient nucleus-smasher. It enables physicists to charge fundamental particles with tremendous energies of the order of millions of volts. When these nuclear bullets enter close to the nucleus of the atom, they generally disrupt it and produce new types of nucleus not to be found in nature. In this way hundreds of new types of atoms, which are mostly unstable have been prepared in the laboratory. These unstable particles emit electrons (of both type) like naturally radioactive bodies *e.g.*, the well-known element radium, and can be used in their places.

But so far it has not been found possible to smash all elements. A limitation is set by the energy which can be imparted to the bombarding particle. The larger it is, the more efficient it is as a nucleus-smasher. Further the heavier the atom, the more energetic must be the nuclear bullet if it is to be properly tackled. The limit so far has been 30 million electron volts. The cyclotron which produces such high-energy particle have a weight of 225 tons. The progress made since 1932, when Lawrence brought out his first baby cyclotron, may be guessed from the fact that this weighed less than half a ton. Larger size is required for producing more energetic particles, because the larger the pole pieces of the cyclotron magnet, the bigger are the spirals which the charged particles can describe.

Not content with making a 225-ton cyclotron Lawrence is now planning to construct a 5000-ton cyclotron. The pole pieces of this apparatus will have a diameter of about 15 feet, and will manufacture nuclear bullets having energies of 100 million volts. Finance for this huge undertaking has been found by Rockefeller Foundation and amounts to nearly 1½ million dollars.

As a measure of safety, this mammoth machine would be housed in a vast laboratory buried in a

hill side. Scientists all over the world will watch the construction of this machine with as much interest as they have watched the construction of the 200-inch telescope, now being mounted in Mount Palomar. The United States of America has been foremost in not only finding out the means of extending our vision to the furthest limits of space, but also in finding out the most powerful nuclear bullets for bringing us nearest to the understanding of the heart of atoms.

Sometime ago Professor A. H. Compton, the celebrated American physicist, remarked in course of a public lecture that to him 'nucleus-busting' appeared to be more important than 'nation-busting'. Probably when the din and bustle and the destruction caused by the present senseless war becomes a distant memory, the story of nucleus-busting and all the benefits which this fundamental research is sure to bring to mankind will remain a monument to the large-visioned co-operation between the physicists, financiers, and engineers of the New World.

Education in World Citizenship

SOMETIME ago the League of Nations established a Council for Education in World Citizenship which found time to hold its inaugural meeting at Oxford in April last in spite of the tragedy which overshadows the Empire and the world of today. The meeting was attended by three hundred delegates among whom were some of the foremost educationists of the day and the success of the meetings far exceeded the anticipations of the organisers. The opening address was delivered by Professor Gilbert Murray on "World Citizenship; the Growth of an Idea". Mr. H. G. Wells and Professor Allan Fergusson opened a discussion on "The Teaching of World Unity; what is being done and what might be done in the schools". Professor C. E. M. Joad delivered an address on "Proposals for Federal Union", and there was a round-table discussion on "Some Guiding Principles for the Next Peace Settlement".

In his opening address Professor Gilbert Murray pointed out the futility of any form of political or economic co-operation unless the same is backed by

intellectual co-operation having a firm ethical basis. World unity, according to Mr. H. G. Wells, is a fact and war is Civil War. The non-combatant has disappeared and the neutral is fast disappearing. Federal notions will lead to failure, because he thinks federated blocks would lead to war on a larger scale. Mr Wells also strongly criticised the present state of affairs in the teaching world. Old-fashioned history that is now taught in schools should be replaced by the study of science of human ecology, the relation of man to his external surroundings. Children should be taught not by telling them stories of kings and queens but by showing them their relation to the world as a whole. Professor Fergusson pointed out the utility of science teaching as an ideal medium for fostering the international outlook, and for exhibiting some of the most important relations of the individual to the community.

Effects of the War on the Minds of Children

A VERY interesting report has recently been presented by Miss Dymond, Principal of the Portsmouth Training College on the "Effects of the War on the minds of the Children". More than 300 English pupils were the subject of experiment and all were in the 12-year age group. Pupils were asked to write without preparation a short essay on "Why are we at war with Germany". Nearly 60 per cent of the boys and girls stated unequivocally that the war was simply due to German aggression. But when asked, "Who is your favourite hero?", very few voted for the outstanding figures of today like Chamberlain or Churchill, and most of them voted for Nelson or Drake. In answer to the question "What would you like to be when you grow up?", few showed any inclination for war-professions. The answers given to the question "What was the most important day of your life" was most interesting and illuminating. Nearly 10 per cent of the pupils who had been evacuated mentioned the day of evacuation or that of the outbreak of the war. A very large number voted for the day on which they sat for the junior scholarship examination. To the question "In what period of history you would have preferred to live?" the majority answered "The present time", the reason put forward being "Because it is more comfortable." Not a few of the girls chose a period when they could wear a picturesque dress.

Generally the investigation showed that the war has had a considerable but not an overwhelming effect on the minds of children.

Carnegie Trust for Scottish Universities

THE latest report of the Carnegie Trust for the Universities of Scotland shows the substantial aids

given in their seventh quinquennial distribution covering the periods 1935-40. An aggregate of £257,300 was distributed. The Trust is generally associated with libraries and students' fees, but a substantial amount is also paid to specialists engaged in scientific research. The subjects studied by such specialists range from the Atlantic grey seal to protein metabolism and new synthesis of compounds of therapeutic value. The Trust also subscribes to the production of good books which are not likely to have a popular sale and also give aid to such enterprises as a study of the Roman occupation of Southern Scotland. In the last quinquennium agricultural colleges at Glasgow, Edinburgh and Aberdeen received annual grants. St. Andrews received £33,150 for extensions and Glasgow £59,000 towards the cost of a new chemistry institute. Edinburgh received large sums including an endowment for the study of prehistoric archaeology and ethnology. The Trust has also paid attention to making arrangements to meet the difficulties caused by the war.

Next Solar Eclipse of October 1

THE U. S. Naval Observatory, Washington, D.C., has published a communication giving much useful information regarding the total solar eclipse that will take place on October 1, 1940. The booklet is meant for use along the paths of totality of eclipse in South America and South Africa. The times of beginning and ending of the eclipse have been shown over the entire region covered by the eclipse on both continents on two large-scale maps. Data are given dealing with meteorological conditions that prevail in or near the paths of totality and suggestions about the most suitable locations for observation of the eclipse have been made. In addition to the usual astronomical data, sufficient relevant information for those, who plan to make ionospheric observations during the partial or the total phases, in order to test various hypotheses regarding the origin of different layer of the ionosphere, has also been given. An appendix contains temperature, rainfall and cloudiness data compiled from observations within the African region of totality belt at 3, 4 and 5 P.M. during September and October for a period of five years since 1933.

New Printing Process

UNTIL recently liquid inks have been exclusively used in printing and the problem of drying has presented many difficulties to printers. The development of a new process which employs a solid ink drying immediately upon touching the paper promises to solve all those earlier difficulties. This new type of ink is a solid at a temperature of about 200°F. So

while using such inks the press, ink fountain, metal rollers, plate cylinders, etc., are kept warm at a temperature sufficient to keep the ink in a fluid state. On touching the colder paper it at once solidifies. An additional advantage is that the printing plates are left clean after each impression, for the touch of the cold paper freezes the ink and lifts it bodily from the plates. This "Velo Cold Set process" as it is called, has been developed by J. M. Huber of New York City and is now available for rotary presses to which it is particularly adapted.

A Flying Submarine

THE ship-building yards at Yesso, Japan, last year produced a type of pocket submarine only six or seven yards long, but extremely effective in torpedoing. Recently a type of pocket submarine has been evolved there, which after gliding a short distance on the surface, take off into the air and fly like a sea plane. C. E. Tesonuma, the inventor, gave a demonstration of this machine before experts and reporters. The fish-shaped body, nine or ten yards long, plunged completely like ordinary submarines. After some time it rose to the surface and from its upper horizontal surface four bands of steel seemed to open out from each side and gave the machine a wing span of eighteen to twenty yards. Then it seemed to rise and two propeller blades emerged from sunken slots and automatically joined, forming an air-screw which began to turn. Exactly six minutes after the submarine had reached the surface it flew off. This type of flying fish when carrying freight has a range of three hundred miles and can be armed with four torpedoes for use under water or in the air. The whole machine is made almost entirely of duralumin, only the wings are of silk of a special weave. In warfare, beside a warship it will look almost as small as a mosquito in comparison with a large beast, but its load of several hundred-weight of explosives will no doubt make it a deadly insect.

Manufacture of Drugs & Chemicals in India

"IF THE required basic materials and chemicals are readily available, it is possible to produce in India all the drug requirements of the country," states the report recently submitted to the Government of India by the Medicinal Preparations Sub-committee of the Indian Chemical Manufacturers' Association. The Sub-committee was presided over by Lt.-Col. R. N. Chopra, Director of the School of Tropical Medicine and of the Biochemical Standardisation Laboratory, Calcutta. The Sub-committee observes that the drug and pharmaceutical industry in India

has developed considerably recently and in order to enable it to make further headway, simultaneous growth of heavy and fine chemical industries connected with coal carbonisation and production of solvents etc., is essential. India possesses a wonderful range of vegetable materia medica and nearly three-fourths of the drugs mentioned in the British Pharmacopoeia grow in this country in a state of nature and the remaining one-fourth can be easily cultivated in some part of the country or other. If due attention is paid to proper cultivation and utilisation of vegetable drugs, India would not only be completely self-supporting in this respect but would also be able to develop an export trade in crude vegetable drugs.

Referring to the position of the country in regard to production of oils, the Sub-committee states that India consumes a large quantity of oils of sandal, pepperment, lavender, lemon, orange etc., for perfumery and pharmaceutical purposes. Although the basic material for the production of a large number of these essential oils are available in India she imports large quantities of these and similar essences from foreign countries. If sufficient attention is paid and necessary encouragement and help are forthcoming, the essential oil industry* in this country can be easily revived and put on modern lines.

Several lists of essential drugs and medicinal chemicals available in India, and of basic chemicals necessary for the manufacture of drugs and several tables showing imports of drugs and proprietary medicines and chemicals along with their industrial uses, have been included in the report.

The Sub-committee has drawn the attention of the Government to the necessity of close co-operation between the drug manufacturing concerns and hospitals. The Government have also been urged to help the chemical manufacturers in India in making a clinical trial of their products in the Government-managed hospitals.

Animal Health in India

THE Advisory Board of the Imperial Council of Agricultural Research at its twenty-first meeting held in Simla on June 27-29, considered various proposals regarding improvement of animal health in India. The artificial insemination of livestock is to be investigated by the Imperial Veterinary Research Institute, Izatnagar, under a five-year scheme approved by the Advisory Board. Artificial insemination has already been attempted in other parts of

* See SCIENCE AND CULTURE, 5, 108, 355, 1939-40, for articles on this subject by Mr. J. N. Rakshit.

the world, particularly in countries in which pedigree sires are few, as it enables more use to be made of such sires. The Advisory Board approved of the grant of Rs. 95,000 for the five-year scheme of investigation at Izatnagar.

Research on sheep breeding in progress in Bombay is to be extended to the villages by setting up a sub-station of the Bhamburda farm in their midst. Research on goat breeding which has been carried on for ten years at Etah in the United Provinces is to be extended, but, in future, work will be confined to the Bar-bari goat, which has been found to be an economical milk producer. The Advisory Board approved of the grant of funds for the preparation of a critical monograph on the "Anatomy of the Ox". No text book devoted specially to the anatomy of the ox has ever been produced anywhere, and it is considered that such a text book is desirable in view of the importance of the ox in India.

The Board considered the report of an officer who has for two years been investigating indigenous systems of veterinary medicine. The report shows that there is in India a large number of village "cow doctors" who are treating livestock, and also a large number of ancient manuscripts and literature which may contain useful material regarding the care and treatment of animals. Some of the manuscripts date back at least 2,000 years. The Board expressed the opinion that it would be useful to continue the investigation of these old manuscripts and suggested that one or more of the Indian universities might apply to the Imperial Council of Agricultural Research for funds for the appointment of a research worker for this purpose.

A few months ago, the Vice-Chairman of the Imperial Council of Agricultural Research, after an extensive tour in several provinces, made suggestions regarding animal health and welfare work in rural areas. He suggested that more use could be made of the staff of nearly 2,000 trained veterinary subordinates now working in rural areas in provinces and States if more attention were directed towards maintaining animals in health, particularly to the production and management of young stock, proper feeding and housing, and elimination of the unfit. The Advisory Board considered the suggestions and it was agreed that the basis of an animal health service should be the institution of a livestock research station in each province and major State. These stations would provide facilities for the investigation of diseases and problems concerning feeding and breeding of animals. It was pointed out that in some provinces, at least, it would be possible with the existing staff and very little

additional expense to establish livestock research stations without much delay.

Other schemes sanctioned by the Board were for the investigation of anaerobic diseases of livestock and a scheme for the production of a vaccine to protect cattle against foot and mouth disease.

Announcements

It is announced in *Science* that Professor F. Joliot and Madame Irene Curie-Joliot have been awarded the 1940 Barnard gold medal of Columbia University for meritorious service to science. The medal is awarded to the person, who within five years just preceding has made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race as in the judgment of the National Academy of Sciences of the United States is esteemed most worthy of such honour.

THE King has approved the award of the Royal medals of the Royal Geographical Society as follows: Founder's medal to Mr and Mrs Harold Ingrams for their exploration, travel and studies in the Hadhramaut; Patron's medal to Lt. Alexander R. Glen for his expeditions in Spitzbergen and North East Land.

AN association of the name of Science Club has been organised at Calcutta by some young scientists with a view to fostering a close social and cultural relationship among the scientific workers and persons interested in the science. The Science Club provides opportunities for both study and recreation. It arranges every month general discourses on scientific topics and also sectional meetings devoted specially to the different branches of science. Persons interested in the Club may get further information from the Secretary at 20, Rani Sankari Lane, Kalighat P.O., Calcutta.

AN Indian Eugenics Society has been formed at Calcutta with the object of studying the principles of human genetics and racial hygiene and their practical applications for the betterment of the Indian population. The Society hopes to work in co-operation with other scientific bodies working in the field of eugenics, like the International Human Heredity Committee, the International Commission of Eugenics, etc. It proposes to carry out investigations of medico-legal and criminological nature on behalf of recognised bodies or bonafide individuals. The office of the Society is at present located at 60/rB, Chakrabere Road North, Calcutta.

MR B. B. RAY, who was associated with the Associated Electrical Industries (India) Ltd., has been appointed Electrical Engineer and Electric Inspector

of the Orissa Government. During his stay in England where he obtained his M.Sc. (Eng.) from London University, he found opportunity along with his research studies for practical training under Messrs. British Thomson-Houston Co. He is a fellow of the Institute of Physics and an associate member of the Institute of Electrical Engineers.

THE Council of the Pharmaceutical Society of Great Britain has elected Colonel R. N. Chopra, Director, School of Tropical Medicine and of the Biochemical Standardisation Laboratory as an honorary member of the Society as a recognition of the work done by him and his colleagues for the advancement of pharmacy in India.

RESEARCH FOR NATIONAL WELFARE

WILL it not therefore be a good policy to take the warning in time, and create, whether for emergent military needs or for permanent national work, a National Research Council, with a National Committee for Industrial and Scientific Research as one of its component bodies and with a constitution similar to that of the Imperial Council of Agricultural Research, or better on the model of the Department of Industrial and Scientific Research in the United Kingdom? We have reasons to believe that this course will not commend itself to the Government of India—that they will merely create a department with a director, and proclaim that their duty has been done. But our idea of a Research Council is entirely different. It will be a body which will draw up a plan of industrial research extending over years, mobilize the available talents in this country (professors of scientific subjects in the universities and research institutes) by distribution of problems, and help them in their work by the award of adequate research grants. Wherever necessary, new research institutions will have to be created. The problems should be of a country-wide interest, and should deal with the essential points in large-scale industrialization. In this connection, we may quote from the late Lord Rutherford:—

"If the research is to be of real and lasting value, it must be carried out in the interest of the country as a whole and not of any particular province or area. This necessitates careful planning and careful co-ordination of various schemes for research in all branches of science, whether pure or applied. In formulating the future policy, India should profit by the experience of Canada and Australia where the working of the scientific departments of the State or Provincial Governments *vis-a-vis* those of the Central or Federal Government has shown 'that the research organizations of the country should be truly national and responsible to the Federal Government alone'. Even in an Empire, of the size of India, where the resources and needs of various provinces are widely different, it would seem that centralized organization of research is the only way of avoiding waste of money and effort, that detailed planning of research must be in the hands of those with the necessary specialized knowledge, and they must be able to act without suspicion of political or racial influence."

—Science and Culture.

[In view of the recent developments in the scientific activities of our country, we make no apology for quoting from an editorial on "The Next Twenty-five Years of Science" written for the first number of the fourth volume published in July, 1938.

—Editor.]

SCIENCE IN INDUSTRY

Oil Wells at Ocean Beds

OIL wells have been drilled on the California coast from the extreme ends of piers stretching out into water. But recently oil is being taken from wells drilled under ocean at distances from three quarters of a mile to two miles. During prospecting, seismographic observations were made over an area of 236,000 acres on the bed of Galveston Bay out of which a detailed survey was made over an area of 48,000 acres. The workers lived in houseboats and worked from special barges and boats. The first source was a buried dome, the well on which was drilled to a depth of 6030 feet. Two more wells were drilled from pile foundations. But at present, a large barge with a drilling platform is sunk after filling with water over the location for the well and drilling is done from a rotary table on the surface of the Bay. So far the work area has not been more than 12 feet deep. The sunk barge takes 12 to 18 hours to be lifted and shifted to a new position. Up till now 11 wells have been made.

Silk Proteins

RAW silk fibre has been found to consist of at least two proteins, Silk Fibroin and Silk Sericin. The Sericin protects the Fibroin by forming a coating over it and gives 15 to 30% of the total weight of the raw fibre. When silk is to be dyed, Sericin requires to be removed. Hot soap solutions are used to remove this Sericin. So long there was some differences of opinions as to whether Sericin is a single protein substance or a mixture of proteins, and it was believed one or the other proteins improved some ultimate properties of the silk. After an investigation it has been found that Sericin is not a mixture of proteins but the fractions which are found and denoted as Sericin A and Sericin B etc., are due to the hydrolytic decomposition depending on duration of treatment in the autoclaves. First the so-called Sericin B is obtained which is then converted into a more soluble form which has been known as Sericin A.

Glycerine-free Explosives

GLYCERINE when mixed with nitric acid gives a powerful explosive, which forms the main component

of dynamite. Another ingredient of explosives is toluene obtained from coal tar and coal gas, and T.N.T. or trinitrotoluene is the explosive. But now explosives can be made from formaldehyde, acetaldehyde and nitric acid, which are known as pentaerythritol tetranitrate or in short, P.E.T.N. It is not more destructive than standard military explosives but its advantage lies in not requiring glycerine for its manufacture. It is reported that Germany is already using P.E.T.N. at least for industrial purposes and is thus releasing more of glycerine explosives for use in shells, bombs, torpedoes, mines and depth charges.

Tarnishing of Stainless Steels

THE so-called stainless steels owe their name to their stubborn behaviour towards tarnishing and rusting like ordinary iron and steels when exposed at ordinary temperatures. It is believed that their is no oxidation of the bright surface of these stainless steels which causes the rust to form in the ordinary cases. But it has been found that any piece of iron or steel on exposure to atmosphere is immediately covered with a thin film of oxide which is called the passive film. This initial film in the case of stainless steels does not increase in thickness as in the ordinary irons and steels where the film is visible due to its increased thickness. This later gradually grows as rust. The brightness of the surface of stainless steels remains unimpaired because the thin film cannot be distinguished from the original surface. This non-tarnishing property of these steels applies particularly to atmospheric exposure. At temperatures between 700 and 800°C in a high vacuum, specimens of stainless steel, either the cutlery type with 12 percent of chromium or the familiar 18 chromium-8 nickel steel, were decidedly tarnished, whereas iron and many types of steel including low-chromium steels with not more than 5 per cent of chromium, remained bright. Not only did ordinary iron fail to tarnish under these conditions, but tarnish films which had been formed by prior heating of the specimens in air were completely removed by this treatment. At elevated temperatures and in vacuum the oxide films tend to decompose and this tendency increases with

increasing temperature. Under the conditions of these experiments the film on ordinary iron or steel decomposed below 700°C but the film on stainless steel was stable up to about 1000°C . Specimens of stainless steel can therefore be annealed without tarnishing only at temperatures above 1000°C .

Agricultural Research in Bombay

At numerous Government research stations and experimental farms a large number of scientific investigations into agricultural problems are being carried out with the assistance of the Imperial Council of Agricultural Research, the Indian Central Cotton Committee and the Sir Sassoon David Trust Fund, in addition to increased financial provision for scientific research work on agricultural problems being made by the Bombay Government. Interesting results have been obtained from the study of the variations in the properties of soil types in their different depths and such work, it is anticipated, will facilitate the preparation of large-scale soil maps of the Deccan canal tracts.

A cheaper and more effective method of converting cane trash into compost has been worked out and the final product has been found to be more economical than farmyard manure. The dry farming research scheme at Bijapur and Sholapur has again resulted in increased yields of both grain and straw.

The botanical work on cotton improvement in Surat is aiming at the production of a type of cotton with a higher ginning percentage and better yield of seed cotton per acre than the improved type (1027 A.L.F.) which is being widely grown in the district. The object of the Broach cotton breeding scheme is the combination of all desirable economic characters—high yield, high ginning percentage, better quality and wilt resistance—in one cotton suitable for wide extension in the cotton-growing tracts of the Broach and Panch Mahal districts.

The work is still in progress here and at other stations where also the local varieties are being improved.

As regards livestock improvement, the Department is paying special attention at the Chharodi Farm to the production of an economical animal with the desired breed characteristics. At Bankapur the herd of Amrit Mahal cattle has now reached a high degree of uniformity in type and conformation. With a view to finding a method of storage, practically all the important fruits and vegetables produced in India have been experimented with at the Cold Storage Research Scheme Station at Ganeshkhind and their suitable cold storage temperatures have been ascertained and recorded.

Glycerine from Petroleum

The main source of glycerine is soap industry. It occurs in combination with the vegetable and animal oils and fats used in preparing soap. But now the restricted quantity available so long will be increased as a new source has been announced. This will prevent the wild and sometimes unnecessary fluctuations in the market price of this commodity. The research workers of the Shell Development Company have developed a process whereby propylene, a gaseous component, obtained as a product of cracking of petroleum, i.e., by heating petroleum under pressure, is acted upon by chlorine to produce at low cost the compound allyl chloride. This product forms the base of trichloropropane which resembles glycerol in molecular structure and is easily converted into glycerol by the action of an alkali. Besides the use of glycerine in the manufacture of dynamites, its other uses are in (i) anti-freeze solution, especially for automobile radiators in cold countries, (ii) in preserving fruits and tobacco, (iii) in cosmetics and skin preparations and (iv) in medicines and as a preservative as boroglyceride.

Thoria from Monazite Sands

NARESH CHANDRA MOOKERJEE

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Prior to the invention of the rare earth gas mantle in 1885, there was practically no demand for monazite; the small quantity required was obtained at a high price from Scandinavia and the Urals. But with the advent of C.A. von Welsbach's gas mantle,

there was a great demand for thoria and ceria earths and a systematic search was made for the sources of rare earths and it has been found that the earths are not so rare as the name implies. From the commercial point of view, the most important source is

monazite (meaning 'to be solitary'). It was so named because when it was first discovered, it was considered to be of extremely rare occurrence. The mineral is at present found in Norway, Urals, Brazil, Canada and India.

MONAZITE, THE RICHEST SOURCE OF THORIA

The mineral monazite is a constituent of monazite sands as the deposit is called. It is essentially an orthophosphate of ceria earths. Mann represents the formula by $n\text{Th}_3(\text{PO}_4)_4 \cdot n(\text{Ce.La.Pr.Nd})_4(\text{PO}_4)_4$, where the first component is regarded as the primary constituent from which thorite is formed by weathering. Dunnington suggested that orangite (ThSiO_4) is mechanically mixed with the monazite and thoria is *not* an essential constituent. Penfield supported this conclusion and claimed to have detected particles of thorite or orangite microscopically and found the ratio of $\text{R}_2\text{O}_3 : \text{P}_2\text{O}_5$ to be unity, R denoting the rare earths and also the ratio of $\text{ThO}_2 : \text{SiO}_2$ to be unity. Preis supported Penfield's conclusion but Blomstrand objected to it. He found that SiO_2 is never absent, but its amount does not depend on the amount of thoria which is present. The thoria present partly combines with silica and partly with P_2O_5 and, finally, rare earths are not sufficient to satisfy the ratio $\text{R}_2\text{O}_3 : \text{P}_2\text{O}_5 = 1$. The thoria is therefore regarded as a primary constituent of monazite sand.

MONAZITE DEPOSITS

In India, the State of Travancore possesses a very rich and extensive deposit of monazite sands. In 1909, representatives of an English registered mining company discovered rich deposits of monazite on the sea-coasts of Travancore which were found to contain monazite twice as rich in thoria as the pure Brazilian deposit. The monazite sands of Travancore owe their economic importance to the fact that they contain a high percentage of thoria (from which thorium nitrate used in the manufacture of gas mantle is derived), ceria and other rare earths. The percentage of thoria in monazite varies between 1 and 12 but the mineral containing less than $3\frac{1}{2}\%$ cannot be profitably used in the manufacture of thorium nitrate. In 1911, near Cape Comorin these sands were found by a concern which eventually came under German control and the concentrates to the extent of 3,200 tons extracted during 1911 and 1913 were said to have been shipped to Hamburg, the manufacture of thorium nitrate in India having never been attempted. Monazite also occurs in the sands to the east of Cape Comorin in the Tinnevely

district of the Madras Presidency and again near Waltair in Vizagapatam, as also on the sea-coast of Orissa. A crystalline variety containing only $2\frac{1}{4}\%$ of thorium has been found in the pegmatites of the Bangalore district in the Mysore State. Deposits have also been found to exist in the Gaya district of Behar and in Tavoy and Mergui in Burma.

Previous to the discovery of monazite in Travancore, Brazil enjoyed a monopoly. The Brazilian industry suffered a setback during the Great War and the post-War period. During 1919-1922, the average production was only 437 metric tons. The production of monazite in India increased to 2,117 tons in 1918 after which there was a gradual decline till 1925, when the output amounted to only 1 cwt. There has been an appreciable revival since 1925 due to the increasing demands for ilmenite, a mineral associated with monazite and obtained as a kind of by-product from the latter. The Orissa deposit is mainly ilmenite associated with monazite which on being mechanically separated has been found to contain about 61% of rare earths and the percentage of thoria is about 7.9. The sand is therefore richer in thoria than that from many other sources, excepting the Travancore deposit.

The Travancore deposit as worked from 1910-14 occurs on the sea-shore, chiefly to the north of Quilon, monazite having been found to cover an area of 1,427 acres. A rough estimate by Mr I. C. Chacko of the Geological Survey of India places the probable amount of monazite available at about 1,776,000 tons. This is based on the assumption that the crude sand contains about 10% monazite and exists to an average depth of 2ft. although in many places, the depth is about 20ft. Recent surveys show that this estimation is too low. The helium content of Travancore monazite sand is of the order of 1 c.c. per gram. It has thus been calculated that for every 100 tons of monazite sand worked up, 100,000 litres of helium are allowed to escape into the atmosphere.

TRADE FIGURES

The world's consumption of monazite is estimated to be about 3000 tons per year. About three-fourths of the world's production is contributed from India and since the ore contains a high percentage of thoria, this corresponds to about 90% of the thorium production of the world. The monthly consumption of thorium nitrate throughout India is reported to be about 15 cwt.; this would correspond to about 150 cwt. of monazite calculating on the average yield of thorium nitrate. The yearly consumption is therefore 1800 cwt. or 90 tons.

The following table indicates the production of monazite in India from 1914 onwards:

Year	Quantity in tons	Value in £
1914	1,186	41,411
1915	1,108	33,238
1916	1,292	37,714
1917	1,940	56,489
1918	2,117	58,819
1919	2,024	40,475
1920	1,641	32,821
1921	1,260	30,959
1922	125	1,871
1923	246	3,697
1924	622	9,301
1925	The production amounted to 1 cwt. only.	
1926	647	947
1927	280	3,810
1928	103	1,242
1929	180	1,800
1930	14	140
1931	90	890
1932	654	6,147
1933	139	1,592
1934	1,009	3,769
1935	3,819	12,453
1936	—	—
1937	—	10,797
1938	—	1,797

ANALYSIS OF MONAZITE

Analyses of monazite have been made by many authors; the representative typical figures are given below—

Travancore monazite.		Brazil monazite.	
Thoria	9.43%	Thoria	6.06%
Ceria	31.9%	Ceria	62.12%
Lanthana	28%	Lanthana	
Yttria	0.46%	Yttria	0.8%
Fe ₂ O ₃	0.14%	Fe ₂ O ₃	0.97%
Alumina	0.14%	Alumina	0.1%
P ₂ O ₅	26.82%	P ₂ O ₅	28.5%
SiO ₂	1%	SiO ₂	0.75%

EXTRACTION OF THORIA FROM MONAZITE

The extraction of pure thorium compounds from monazite is a process of much technical difficulty; the percentage of thoria is small whereas that of the ceria oxides is high. The exact method by which the extraction of thorium from monazite is effected cannot be stated definitely since it constitutes a secret process. The following description may be

given based on published accounts and patent specifications of the commercial methods of extraction.

The finely powdered monazite sand is heated with about twice its weight of conc. H₂SO₄ in cast iron pans for 4—6 hours during which time it is stirred continuously; eventually the mixture sets to a pasty mass of sulphates. The semi-solid mass is then treated with cold water whereby the sulphates are dissolved. The solution thus obtained should be strongly acid and this fact is made use of to gauge the success or otherwise of the decomposition of the mineral. If the solution is not strongly acid, then it is known that the decomposition of the mineral is not complete. The solution is now poured from the undissolved material which consists of quartz, magnetic iron ore, iron titanate, zirconium silicate, titanate acid. The solution is then partly neutralised with magnesia. This effects the precipitation of most of the thorium as phosphate. The precipitate is removed and the filtrate completely neutralised when the residue of the thorium and all other rare earths are precipitated as phosphates. By this treatment, a considerable concentration of thorium is effected. Since thorium phosphate is insoluble in dilute acids, the same result can be brought about by largely diluting the solution of the sulphates. The phosphates are dissolved in HCl and the strongly acid solution treated with excess oxalic acid. This treatment serves two purposes; in the first place, it removes thorium from phosphoric acid and in the second place, it effects a partial separation of the rare earths, for the oxalates of these substances are more soluble in concentrated acid than that of thorium. The precipitate thus obtained is filtered off. The crude oxalate is then thoroughly digested with a concentrated solution of Na₂CO₃. This carbonate of cerium elements are much less soluble in Na₂CO₃ solution than thorium carbonate. After thorough digestion, the liquid is filtered from the undissolved residue. The thorium is reprecipitated from the filtrate as oxalate by HCl. The process is again repeated and a final digestion is then made with (NH₄)₂CO₃; addition of alkali to the clear filtrate now gives Th(OH)₄ in a sufficiently pure condition to be used for the last refining.

The object of the last stage is to remove from the thorium compound small quantities of cerium and yttrium salts which cannot be separated by the carbonate method. The chief process is the sulphate crystallisation.

The Th(OH)₄ to be purified is dissolved in H₂SO₄ and Th(SO₄)₄ is obtained by evaporation of the solvent until it becomes anhydrous. This is dissolved to saturation at 0°C and the solution is raised to the boiling point, the enne hydrate being precipitated. This treatment is repeated several times.

This gives an impure product. This was modified by Cleve and Witt.

The crude sulphate is boiled with ammonia and the hydroxide dissolved in HCl. Addition of H_2SO_4 in the cold transforms the chloride into sulphate which separates as the octa hydrates at ordinary temperatures. Three repetitions give a satisfactory product and in this form the method is much used.

There are other methods of purification and separation: (i) Fractional crystallisations of bromates, halides, nitrates, Double nitrates, formates, acetates, acetyl acetates, dimethyl phosphates, picrates, *m*-nitro benzene sulphonates, sulphanilates. (ii) Fractional precipitation by NH_4OH , organic bases, cuprous oxides, basic oxides, alkali azides, $\text{Na}_2\text{S}_2\text{O}_3$, fluorides or fluorosilicates, chlorides and oxy-chlorides, iodates, BaCO_3 , chromic acid and chromates. (iii) Fractional decomposition of carbides. (iv) Fractional precipitation with $\text{K}_4\text{Fe}(\text{CN})_6$, alkali nitrates, stearic acid, citric acid and citrates. But almost all these methods are of theoretical importance as they involve a heavy cost of production.

The difficulty in getting pure thoria is due to its close similarity to ceria and other earths in some of its chemical properties. Another important point which cannot be overlooked is the complete separation of phosphorus. Phosphorus must be completely removed, since 0.005% of phosphorus deteriorates the property of the mantle for which thoria is mostly used. Smith and James in 1912 showed that if a slight excess of a hot concentrated solution of sebacic acid is added to a boiling, neutral or faintly acid solution of the mixed nitrates, thorium sebacate is precipitated quantitatively and they suggested that this method can be profitably employed in separating thorium from other rare earths in monazite sand.

This method was tried in our laboratory with fairly satisfactory results. The product obtained was fairly pure with about 2-3% cerium and traces of other rare earths. But the main drawback of the process is that from the industrial standpoint, the cost of production was high. Work is in progress in our laboratory to find out a more suitable and easier method for getting thoria.

ESTIMATION OF THORIA

There are different methods for the estimation of thoria, *e.g.*, (i) Sodium Thio-sulphate method, (ii) Hydrogen peroxide method, (iii) Iodate method, (iv) Hypophosphate method, (v) Pyrophosphate method, (vi) Volumetric estimation by ammonium molybdate using diphenyl carbazide as outside indicator, (vii) Hexamine method. Methods (i), (ii) and (v) cannot be carried out in acid solutions and also

they are very tedious requiring 3-4 days for each analysis. The hypophosphate and iodate method can be carried out in acid solution and the iodate method is considered to be the most rapid method for technical analysis requiring about two days. The hexamine method is very recent and its accuracy remains to be confirmed by putting it to repeated tests. As regards the volumetric method, it has been subjected to adverse criticism. Great difficulty is therefore experienced for want of any rapid technical method for the estimation of thorium. Work is being done in our laboratory to find out some convenient method for the rapid and accurate estimation of thorium.

USE OF THORIUM COMPOUNDS

The most important use of thorium nitrate is found in the manufacture of gas mantles for incandescent lighting. Thoria is an extremely valuable catalyst in certain organic reactions. Thorium compounds find use in several devices for intense lighting. Thus small cylinders after the nature of "limes" used in lime light lanterns, made of thoria mixed with ceria are used for the head lights of motors cars and also for search lights. Thorium tungstate, chromate and other salts are mixed with powdered magnesium in the production of flash light powders. The filaments of the later forms of Nernst lamp are composed of a mixture of thoria yttria and zirconia, to which sometimes small quantities of ceria are added. Alloys of thorium and tungsten are used in the production of electric lamps.

INCANDESCENT GAS MANTLE INDUSTRY

The mantle as purchased from the market consists of a skeleton composed of a mixture of oxides of thorium (99%) and cerium (1%) held together by asbestos and stiffened by impregnation with collodion. This is Auer von Welsbach's specification. This will give the most brilliant illumination.

Cotton fibre was originally used in the manufacture of mantles; now this has been supplanted by artificial silk and ramie fibre. The web is soaked for 5 hours in a solution of 1000 gms. of thorium nitrate, 10 gms. of cerium nitrate, 5 gms. of glucinum nitrate and 1.5 gms. of magnesium nitrate in 2 kilos of water. The webs are then passed through rollers to remove excess of the solution. They are then dried at 30°C. After drying, the mantles are formed, fitted with asbestos loops and other supports, and strengthened by coating the top and bottom with thorium solution containing salts of calcium, aluminium and magnesium. At this stage, the mantle

may be branded by stamping with a paste of 1 kg. didymium nitrate, 200 gms. of glycerine, 25 gms. of methylene blue, 300 gms. 96% alcohol and 300 gms. distilled water. The mantle is now shaped on a wooden frame and burnt off with Bunsen flame starting at the top.

The next process is that of hardening, which is carried out by raising the mantle to a high tempera-

ture for a few minutes. The mantle is now finished, but is so fragile that any movement is likely to break it. Consequently, before it can be put on the market it must be strengthened. This is done by immersing it in a solution of 100 gms. 4% collodion, 40 gms. ether, 6.5 gms. camphor and 3.5 gms. castor oil and then drying at 50°—60°C.*

* Read before the Calcutta University Chemical Club.

Board of Scientific and Industrial Research at Work

WE are glad to learn that the Government of India have decided to make the Government Test House at Alipore, Calcutta, the centre of activities of the newly created Board of Scientific and Industrial Research. Professor S. S. Bhatnagar, the newly appointed Director of Scientific and Industrial Research, is already in Calcutta and has taken charge of the Test House. Dr S. Parthasarthy, who has been appointed as Technical Secretary of the Board has also shifted his office to the Test House. We hope that within a short time the Test House will expand its activities and grow up into fully fledged and distinct National Physical and Chemical Laboratories.

The last meeting of the B. S. I. R. was held at Simla on the 8th and the 10th June last where a large number of research schemes submitted by universities and research institutes and individual workers were examined. The Board made a number of recommendations and the Government of India have been pleased to accept them and have sanctioned the formation of a number of research committees to deal with the schemes. The following is the list of these research committees formed so far:

I. Vegetable Oils Committee.

Dr S. S. Bhatnagar (Chairman), Dr M. N. Goswami and Mr J. A. Narialwala.

II. Fertilisers Committee.

Dr J. C. Ghosh (Chairman), Dr Cyril S. Fox and Dr S. S. Bhatnagar.

III. Drugs Committee.

Dr J. N. Ray (Chairman), Dr P. C. Mitter, Dr S. Siddiqui, Dr P. C. Guha and Dr K. Hameed.

IV. Plastics Committee.

Dr S. S. Bhatnagar (Chairman), Dr J. C. Ghosh, Dr M. N. Goswami, Dr H. K. Sen and Dr Habib Hussain.

V. Sulphur Committee.

Dr S. S. Bhatnagar (Chairman), Dr J. C. Ghosh and Dr Cyril S. Fox.

VI. Scientific Instruments Committee.

Dr M. N. Saha (Chairman), Dr S. K. Mitra, Mr K. Aston, Sir C. V. Raman, Dr H. P. Waran, Mr R. C. Malcolm and Dr A. L. Narayan.

The functions of these committees would be to organise and supervise the various schemes approved by the Government of India within the field of research allotted to each. The individual members of the committees need not necessarily take up the execution of any of the research schemes themselves, but each committee as a whole will have to watch the progress of each scheme, formulate co-ordinated proposals for further schemes in the respective subjects and, in general, assist the Government in ensuring that the grants are carefully utilised so as to secure the best possible results. The committees will obtain periodical reports from the research workers at such intervals as they may consider necessary. These research committees are expected to meet once a year and examine the research schemes submitted to them. These will then be forwarded to the Board which will discuss them on their merits and send their recommendations to the Government of India. Each one of the research committees has been provided with financial grants.

Besides, certain individual grants have also been provided.

We are narrating in brief the work which will be done by these committees. Vegetable oil seeds had been exported in huge quantities which used to come back in the form of fuel oils and synthetic chemicals. Owing to shipping difficulties the export of these oil seeds has fallen off very greatly. Researches will help to manufacture these products which we have been importing so long. One of the schemes before the Fertilisers Committee is, we understand, related to the manufacture of urea from ammonia and carbon dioxide for use as fertilisers. About the drugs it may be interesting to know that herbaceous and medicinal plants for the manufacture of nearly three-fourths of the drugs mentioned in the British and other pharmacopoeias are growing in our country but these have never been commercially utilised. The pharmacopoeial species which are not available here may be substituted by allied species in the light of researches. Further, the Drugs Committee will be responsible for a new industry which is very important to national life. Some of the vegetable oils are not being hitherto commercially exploited and the uses of lac are greatly diminishing due to synthetic products. Already plastic materials have been prepared out of these oils and lac and further research will point the way to a stable industry. Sulphur is the basic material for sulphuric acid on which the whole chemical industry and the different key industries depend to a large extent. But sulphur deposits have not yet been found in India. The Geological Survey of India are hopeful of boring into natural sulphur in Baluchistan. But a more probable source would be gypsum, which is the calcium salt of sulphuric acid, and the low grade coals of Assam. Of the six committees detailed above the Scientific Instrument Committee figures prominently and it has a pre-eminent place in any scheme of scientific research. We are now feeling how hopelessly ill-equipped we are when due to the present abnormalities in trade the essential equipments are not available and schemes are likely to be put in abeyance.

Besides the above research committees, a number of exploratory committees have been appointed to find out the possibilities of research on the respective lines. The names of these committees and their personnel are given below.

I. Graphite Carbon & Electrode Committee.

Dr J. C. Ghosh (Chairman), Mr K. Aston and Mr M. L. Joshi.

II. Molasses Committee.

Dr B. C. Guha (Chairman), Dr H. D. Sen and Mr M. Sreenivasaya.

III. Glass & Refractories Committee.

Sir C. V. Raman (Chairman), Dr Nadel, Mr Varshney (Senior), Mr N. C. Nag and Mr M. L. Joshi.

IV. Vegetable Dyes Committee.

Dr. S. Krishna (Chairman), Dr K. Venkataraman, and Supdt. Government Silk Institute, Bhagalpore.

V. Fuel Research Committee.

Dr H. K. Sen (Chairman), Dr Forrester, Dr S. D. Muzaffar and Mr Amritlal Ojha.

VI. Cellulose Research Committee.

Lala Shri Ram (Chairman), Dr Nazir Ahmad and Dr J. K. Chowdhury.

Though the war provided the immediate incentive for the formation of the Board which has an initial term of two years, we hope the Board's work will gradually exceed that of providing for the necessities of the country created due to the exigencies of the war and would soon be a permanent body to further industrial research on organised lines and help industries in general. The B. S. I. R. has started on a line, which admits of much improvement in its method of work and in the matter of recruitment of scientific workers, but we believe that these developments will come as a result of experience and it will not be many years before it develops on the lines of the Department of Scientific and Industrial Research in the United Kingdom.

We have already expressed our view in these columns that for industrial and scientific research there should exist two distinct chemical and physical laboratories, each with its own director, and there should be a number of separate research stations with their own directors, each devoted to a particular problem, such as fuel research, food research etc. These research laboratories should not, however, be entrusted with monopoly to carry out all the works and therefore research grants should be liberally provided to workers in the universities who may be willing to take part in industrial research. It needs no emphasis that the first principle underlying collective work is team spirit. No good work can be expected from a staff which always suffers from a sense of

inferiority and inadequate financial prospects. Methods of recruitment, pay and prospects of research workers, as they obtain at present, are very unsatisfactory and possibly do not attract best brains. The whole structure should be replaced by a more rational system. In the actual administration of the Board, the Government of India will profit by following the example of the British Government which have always sought co-operation of more and more non-official scientific men. The Government can, to the best advantage, then relax their own control in favour of such advisory boards of scientific men.

The basic idea behind the formation of the B.S.I.R. is certainly the centralization of responsibility and directing authority so that the best possible use may be made of the materials and brain power. In the course of a survey of industrial research activities made by the Board as a preliminary to launching schemes, it was revealed that some wasteful duplication of work is proceeding and the objects in view of the workers are not broad enough to fit in the country's normal industrial programme. But we understand that the Department of Supply of the Government of India which has recently been expanded to meet war requirements with two divisions, one dealing with engineering capacity and the second with all other supplies, are arranging for each division to have its own research organisation. There has been therefore protest from the public press against this unnecessary expenditure of energy and money by having research schemes under different authorities other than the B.S.I.R. The

Government are not possibly anxious to guarantee prevention of confusion and duplication of efforts in their own undertakings. Experts have been found in these cases to be expensive and not always necessary links in the chain of communication between the origin of demand and the source of supply. A competent clerk in the present case can exchange information between the B.S.I.R. and the chiefs of the Supply Department. We are afraid the press have stopped short in their helpful analysis. When the Government is prepared to defray the expenses of research under the Supply Department we suggest that the sum be transferred to B.S.I.R. funds. The B.S.I.R. can then proceed at a swift pace with the schemes of research and build a framework of industrial research in order to embark on more varieties of work.

The total grant at the disposal of the Board is 5 lakhs of rupees but so far only 3 lakhs have been distributed. The sum asked for in the applications amounted to nearly 15 lakhs. The Board needs to be provided with far larger sums of money by the Government and industrial concerns to enable it to carry out a fairly adequate amount of research work on scientific and industrial subjects. The next meeting of the Board is expected to be held in September at Bombay when more research proposals will be discussed. It is hoped that other industrial centres will also be chosen as venues of meeting and thus close co-operation will be effected between industrialists and men of science, which will help greatly to build Indian industries on stronger foundations.

Rural Employment

[We reproduce below the relevant portion of a letter which Sir Chunilal V. Mehta, a former Minister of Bombay, has written to Prof. K. T. Shah, General Secretary of the National Planning Committee. A copy of this has been forwarded to Prof. M. N. Saha, drawing his attention to the suggestion for the future deliberations of the National Planning Committee. It should be remembered that Sir Chunilal has submitted to the N. P. C. a very helpful report on behalf of the Animal Husbandry and Dairying sub-committee.

The point raised by him deserves public attention for their criticism. Particularly in Bengal, the position may be different but for areas, where there is insufficient rainfall and surface water-sources are absent, the suggestion justifies a scrutiny.

—Editor.]

Bombay,
28th June, 1940.

My dear Prof. Shah,

* * * * *

It is well known that the average cultivator in the dry areas has a large amount of time on his hands

especially in the off-season. While all encouragement should be given to subsidiary cottage industries to utilise their time it appears to me that every effort should be made to find out whether the cultivator

cannot be profitably employed in his own occupation throughout the year. The great hindrance to that at the moment is our seasonal rainfall and the great requirement is a supply of water for cultivation throughout the year. Vast schemes have been undertaken of the nature of major irrigation works at heavy expense but these cover only a comparatively small area of the land and are only practicable where rivers and other large perennial sources of water are available. If an equal amount of attention were paid to what I may term minor irrigation schemes in which not only wells are included but of which they indeed form a major part, we should be able to supply the timely needs of the cultivator at much less cost and provide a supply of water to him which he can use at his own discretion and to suit his own convenience. In fact the object of minor irrigation schemes such as bunding of small streams and of building tanks etc., serve the very useful purpose of raising the subsoil level of water of the area and of feeding the supply of wells so that they may not go dry even in the hot weather.

With a more adequate supply of wells in suitable areas the question of sub-division and fragmentation of holdings would also be dealt with. For, a well can keep under cultivation 3 to 4 acres of land and provide full day's occupation throughout the year, against 20 to 25 dry acres and partial occupation.

Also the expansion of motor transport in rural areas has helped to solve the problem of marketing the produce grown by well irrigation. Generally expensive crops like vegetables and chillies are grown under well irrigation and unless a quick disposal is secured for these perishable articles it would not be profitable or practicable to grow them. These are usually consumed in cities and since motor transport is both extensive and expeditious as compared with the old time cart transport more distant areas can be tapped for supply to towns.

An additional advantage would be, we hope, a greater consumption of vegetables by the cultivators themselves, which would be a very welcome addition to his generally poor dietary.

Well irrigation is par excellence, the best year-round employment that we can find, an employment to which the cultivator is accustomed and which he likes. Besides being far more profitable than dry cultivation it would help to stop the otherwise inevitable efflux from the villages to cities.

A further advantage will be that, far more attention will be paid to the care and breeding of cattle which in itself would be a useful subsidiary occupation, besides providing manure. It is well known that the working bullocks of the cultivator are the best cared for.

I suggest that in areas determined after a survey an extensive drive should be made for repairs of existing wells and for sinking new wells. Funds should be made available for the purpose by the State and if necessary a loan should be raised, for it will be for a definitely productive purpose even after allowing for a certain number of failures in the sinking of new wells.

A successful experiment has recently been made in Gujerat in devising a suitable concrete or wooden frame-work whereby the cost of putting down the well or of repairing it is very much reduced and the work greatly expedited. This frame-work can be used from one well to another and whatever assistance that has been offered by this means has been eagerly availed of by the cultivators and indeed the demand cannot be met.

Yours sincerely,

(Sd.) *Chunilal V. Mehta.*

MEDICINE & PUBLIC HEALTH

Studies on Indian Diets

METABOLIC experiments were carried out under Dr K. P. Basu at Dacca University with a view to find out the capacities of typical Indian dietaries to supply the essential requirements of the nutritional elements like nitrogen, calcium, phosphorus etc. Three types of diets were chosen, (i) Non-vegetarian rice diet including pulses and fishes, commonly taken by people of Bengal, Assam and some parts of South India, (ii) Vegetarian rice diet as used in Orissa, Madras, Mysore and other parts of South India, and (iii) Vegetarian Atta Diet as used in U. P., the Punjab, parts of Western and Central India.

The average protein requirement to maintain a nitrogen balance was found to be 46.48 protein per 70 kilo body weight. The experimental diet contained on an average about 80 g. protein and the addition of 10 oz. milk increased the protein content to about 89 g. Experiments with the above diets showed that the subjects were not only in systematic positive balance of nitrogen but retained considerable amount of protein in their body. Addition of milk improved these retentions. These dietaries therefore are adequate from the point of view of nitrogen content and utilisation even without milk. The addition of milk however increases the margin of safety and provides first class proteins.

The minimum calcium requirement for health for an adult was found to be 0.648 g. per man per day. Experiments with the above dietaries showed that they are deficient in meeting the calcium requirements of the people. Addition of 10 oz. milk to these dietaries covered just the bare necessity of calcium. Chewing of betel leaves with lime, as practised widely in India, was found to supply considerable amounts of calcium which were well utilised.

Minimum requirement of phosphorus for an adult of 70 kilo body weight was found to be 1.00 per day. All the dietaries supplied not only the minimum requirement but also covered the 50% safety margin even without milk.

P. K. C.

Germ-free Blood

UNSUSPECTED germs in the blood given to a patient may develop serious reactions. Blood for transfusion is always tested for syphilitic infection before use but particular examinations for other germs from healthy blood donors are not made. Besides, germs may get in during drawing of blood or preparing it for storage. To counteract this defect, sulphanilamide, the powerful chemical remedy for a host of germ diseases like pneumonia, streptococcal infection, erysipelas, etc., is being added to blood which prevents the growth of bacteria in the blood for from 10 to 15 days and may even make the blood completely germ-free. The method is due to Dr Milan Novak of the University of Minnesota.

Insulin Suppositories

INSULIN administered per mouth is destroyed by the digestive ferments, pepsin of the stomach and trypsin of the small intestine. Cutaneous, lingual, nasal, and vaginal applications of insulin have been found to be useless. When introduced into the rectum the trypsin present, which is most active in an alkaline medium, destroys the insulin, the reaction of the rectum being alkaline. Brahm (*Lancet*, I, 829, 1940) prepared various insulin suppositories and found that those prepared with cocoa-butter, hydrochloric acid and a saponin were very active when administered per rectum. The action of insulin set in very soon as was revealed by the estimation of the blood sugar level. By varying the concentration of insulin in the suppositories the intensity of its action could be varied at will. This simple mode of administration of insulin is worth a trial.

S. B.

Chemo-therapy in Plague

INVESTIGATIONS carried out at the Haffkine Institute, Bombay, under Lt-Col. S. S. Sokhey showed that Prontosil had no effect on infected mice. M. & B. 693 in 10 times the therapeutic dose also

was ineffective. With 50 times the therapeutic dose however some curative effect was noticed up to 48 hours after infection.

P. K. C.

Infection of Tuberculosis

INVESTIGATION of the incidence of tuberculosis among industrial workers under Dr A. C. Ukil at the All-India Institute of Hygiene and Public is in progress. 3008 workers have been examined up to date. General incidence of tuberculous infection among these workers, as determined by Mantoux test is found to be 89.3%, 37.2% being high reactors i.e., "three plus" and "four plus". Incidence of active disease was found in 5.8% of the workers and evidence of arrested lesions was detected in 72.9%.

Incidence of tuberculosis in contact children was also investigated. 917 children of 15 years and under were examined. 67.9% showed positive reactors to Mantoux test. Demonstrable X-ray lesions were found in 46.7% of which 11.6% showed acute lesions, 6% arrested lesions and 29% tracheobronchial adenopathy.

P. K. C.

Vitamin B₁ and Tic Douloureux

BORSOOK *et al* (*Jour. Amer. Med. Assoc.*, 114, 1421, 1940) have successfully treated most of the cases suffering from spasmodic facial neuralgia (tic douloureux) with vitamin B₁ and concentrated liver extract.

S. B.

Black Lungs

BLACK deposits on lungs found mainly in the bodies of the miners were supposed to be caused due to prolonged breathing in of coal dust. When people of the town were found with black lungs, the explanation was that it was caused by city smoke. Physicians called it anthracosis. But modern chemistry has shown that it is not carbon deposit but it is a heterocyclic compound, i.e., a compound containing one or more rings (a closed molecular structure) in which there are elements other than carbon present. It is distinguished from carbon by its animal smell when burned and by its ability to form colloidal solutions and other chemical reactions. It is now believed to be a substance produced by the body itself, whose history is still to be found out.

Ascorbic Acid in Lead Poisoning

HOLMES *et al* (*Jour. Lab. & Clin. Med.*, 24, 1119, 1939) reported that ascorbic acid is very useful in the treatment of chronic lead poisoning. But Dannenberg *et al* (*Jour. Amer. Med. Assoc.*, 114, 1439, 1940) could not cure a case of lead intoxication even after the use of massive doses of ascorbic acid.

S. B.

Malaria Institute of India

THE annual report of the Malaria Institute of India for the year 1939 gives a résumé of its many-sided activities. Its functions are to advise the Central Government, the Provincial Governments and local bodies on all matters connected with malaria control, to carry out systematic research into the epidemiology and control of malaria and the bionomics of mosquitos, to train medical officers in malariology, to act as a central bureau for the issue of publications dealing with malaria and mosquitos and generally to advise and assist malaria workers throughout India. It also maintains a close contact with malaria workers in other countries, both by correspondence and by the exchange of publications. A six weeks' course in malariology for medical men is held annually at the field station, and many of the officers so trained are doing valuable work in various parts of India. Nearly 300 students have undergone this training since the organisation was first formed in 1927. An important function of the Institute is the testing of the various larvicides and insecticides which are used in malaria control work. Pyrethrum, which forms an essential ingredient of all insecticides, is now being grown successfully in this country, excellent results having been obtained with flowers grown in Kashmir, Kulu and the Nilgiri Hills. India may shortly be able to produce sufficient pyrethrum for her own needs and an efficient insecticidal spray will then be made available at a comparatively low price. In this work, the Malaria Institute is working in close collaboration with the Imperial Council of Agricultural Research.

The intensive anti-malaria campaign now in progress in Delhi urban area is being carried out under the supervision and direction of the Malaria Institute. It is expected that as a result of this campaign the disease will no longer seriously affect the city's activities.

Officers of the Malaria Institute have been called upon to give advice regarding the rural anti-malaria schemes which have been initiated in

various provinces as the result of a grant made by the Government of India. Field research units of the Institute have been working in the Wynaad, South India, and in the Terai district of the United Provinces in collaboration with two of the rural schemes. A third field research unit is carrying out investigations in Orissa in the vicinity of the Chilka Lake.

Laboratory researches include a number of important investigations on monkey malaria, of which several strains have been maintained. These have proved of great value for teaching purposes as well as affording abundant material for research work. Valuable results have also been achieved by the application of the precipitin test to mosquito blood meals. By this means it can be ascertained whether a particular species of mosquito feeds habitually on man or on cattle.

The report of the Entomologist contains an account of a number of investigations regarding the life history and habits of various species of mosquitos. Many collections of mosquitos and other insects were received for identification during the year from all parts of India.

Lady Tata Memorial Awards

THE following are the recipients of international awards of the Lady Tata Memorial Trust for the year 1940-41 for research in diseases of the blood with special reference to leucaemias:

(i) Dr Maurice Paul Jean Guerin, of French nationality, assistant in experimental medicine, Cancer Institute of the Faculty of Medicine, Paris, who will continue and extend the experimental studies of research in the transmissible leucaemias of hens and their relationship to the sarcomas made by Dr Charles Oberling, a former scholar of the Trust for the last five years. He will work under the direction of Prof. G. Roussy, professor of pathology in the Faculty of Medicine, Paris.

(ii) Professor Dr Karl Jarmai, director of the Institute of Pathological Anatomy of the Palatin Joseph University, Budapest, Hungary, who will continue to determine the nature of the agent of the leucaemia and to produce the disease experimentally in laboratory animals.

(iii) Professor Eugene L. Opie and Dr Jacob Furth, both of American nationality,

Cornell University Medical College, New York, who will continue the work in progress upon the leucaemias like diseases of fowls and their relation to neoplasms, and to determine the nature of viruses producing leucaemias and associated neoplasms, lymphomatosis, myelomatosis, endothelioma, sarcomas, etc.

(iv) Dr A. H. T. Robb-Smith, Nuffield reader in pathology and morbid anatomy, Oxford University. The award is an aid to the establishment of a "Lymphnode Registry" in the School of Pathology at Oxford to aim at better classification and follow up of human cases showing progressive hyperplasias and neoplasms of the lymphoreticular tissues including cases of the leucaemias, lymphadenoma, lymphosarcoma, etc.

(v) Dr Werner Jacobson, part-time Sir Halley Stewart fellow at the Strangeways Research Laboratory, Cambridge, who will continue the study of making a histochemical study of the argentaffine cells of the gut epithelium, with a view to determining whether they are the source of the intrinsic factor of castle, and hence their bearing on the problem of pernicious anaemia and other blood diseases.

The following are the Indian scholars under the Lady Tata Memorial Trust for the year 1940-41 for scientific investigations having a bearing on the alleviation of human suffering:

(i) Mr K. Ganapathi, who will continue the work on Synthesis of Compounds of Sulphamylamide Group under the direction of Lt.-Col. S. S. Sokhey, Director, Haffkine Institute, Bombay.

(ii) Mr T. J. Job, who will continue the work on the Practical Utility of Insectivorous Fishes in the Biological control of Mosquitoes under the direction of Rai Bahadur Dr S. L. Hora of Zoological Survey of India, Indian Museum, Calcutta.

(iii) Mr Manmutha Kumar Halder who will continue research on anaemia with special reference to the haematopoietic factors and the availability of iron from different sources for haemoglobin formation under the direction of Dr K. P. Basu of Biochemistry Laboratory, Dacca University.

(iv) Dr Sachchidananda Banerji, who will carry on investigations on the comparative methods for determining the vitamin C status of the body and the rôle of vitamin C in infection under the direction of Dr B. C. Guha, Ghose professor of applied Chemistry, Calcutta University.

(v) Mr G. B. Ramasarma, who will carry on research on vitamin A, specially provitamins and the rôle of fat in their absorption under the direction of Mr B. N. Banerji, of the department of biochemistry, Indian Institute of Science, Bangalore.

Physics in Aid of Medicine

M. N. SAHA

Palit Professor of Physics, Calcutta University.

AND

P. K. SEN CHAUDHURY

(Continued from the last issue)

THE NUCLEUS OF THE ATOM—ITS COMPOSITION

PROBABLY at this stage, we should try to convey to the general reader particularly medicals, some idea of our present knowledge of the nuclei, and their reactions. This is best done by means of a diagram (Fig. 2), but before we come to it, we should say something about the fundamental particles into which the nucleus may ultimately be broken up. According to the modern view, it is

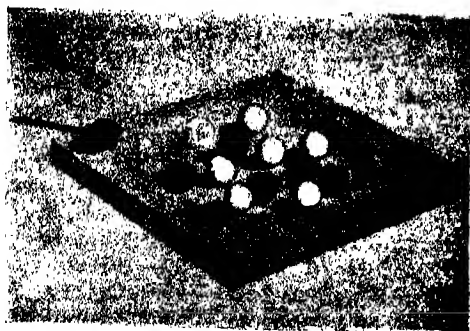


FIG. 1
Diagrammatic representation of the nucleus of an atom. The single ball at the corner is a projectile.

[From Nature]

composed of two fundamental particles (i) the proton, which is the nucleus of the element of hydrogen, and (ii) the neutron which is a new 'Dramatis Personae' in the everchanging drama of physics. It therefore requires a little description. The neutron (See SCIENCE AND CULTURE, Vol. I, p. 15) was discovered only in the year 1932. It has almost the same mass as the proton (in fact the mass of

the neutron is slightly larger) but it has no charge, which gives it unexpected properties. For example, the proton being positively charged, is repelled by nuclei and hence it has a finite range of penetration into matter depending on its energy; further its chance of approaching within a reasonable distance of the nucleus is usually very small unless we give it a tremendous amount of energy, in fact, of the order of millions of electron volts. But not so with the neutron; being uncharged, it encounters resistance neither from the outer shell of electrons, nor from the positive charge of the nucleus. So it can pass through metres of thickness of matter as if matter does not exist at all, and is stopped only when it encounters a nucleus. When it does so, it generally produces a new nucleus with novel properties. You may ask why do we not use the neutrons for 'Nucleus busting' instead of high-energy protons? The answer is that no laboratory chemical or physical reactions can give us the neutron, it can be produced only by some nuclear reaction. It was at first produced by Bothe and Becker by placing polonium on beryllium. Polonium is a radioactive element which constantly emits alpha-rays, a small fraction of which falling on Be, penetrates its nucleus and disrupts it, with the emission of neutrons. Several other laboratory methods are known, but the number of neutrons produced in this way is rather small, and the yield increases substantially only when the energy of the bombarding particles is as large as possible. A very strong stream of neutrons is obtained when high energy deuterons produced in the cyclotron are allowed to act on stationary deuterons (in the form

of a solid deuteride). The need, therefore, for a high voltage generator like the cyclotron for assault on the nucleus remains.

THE STRUCTURE OF THE NUCLEUS

The nucleus may be conceived to be like a sack (see Fig. 1) filled with two different kinds of balls, say black and white, the black ones representing

for the mass number or atomic weight in terms of that of hydrogen as unity, hence it represents the number of particles in the nucleus. The ordinate represents the excess of neutrons over protons in any nucleus. The circles, solid as well as hollow on any diagonal represents the isotopes of any element. Thus taking the first diagonal we find that the element hydrogen has four isotopes, of mass

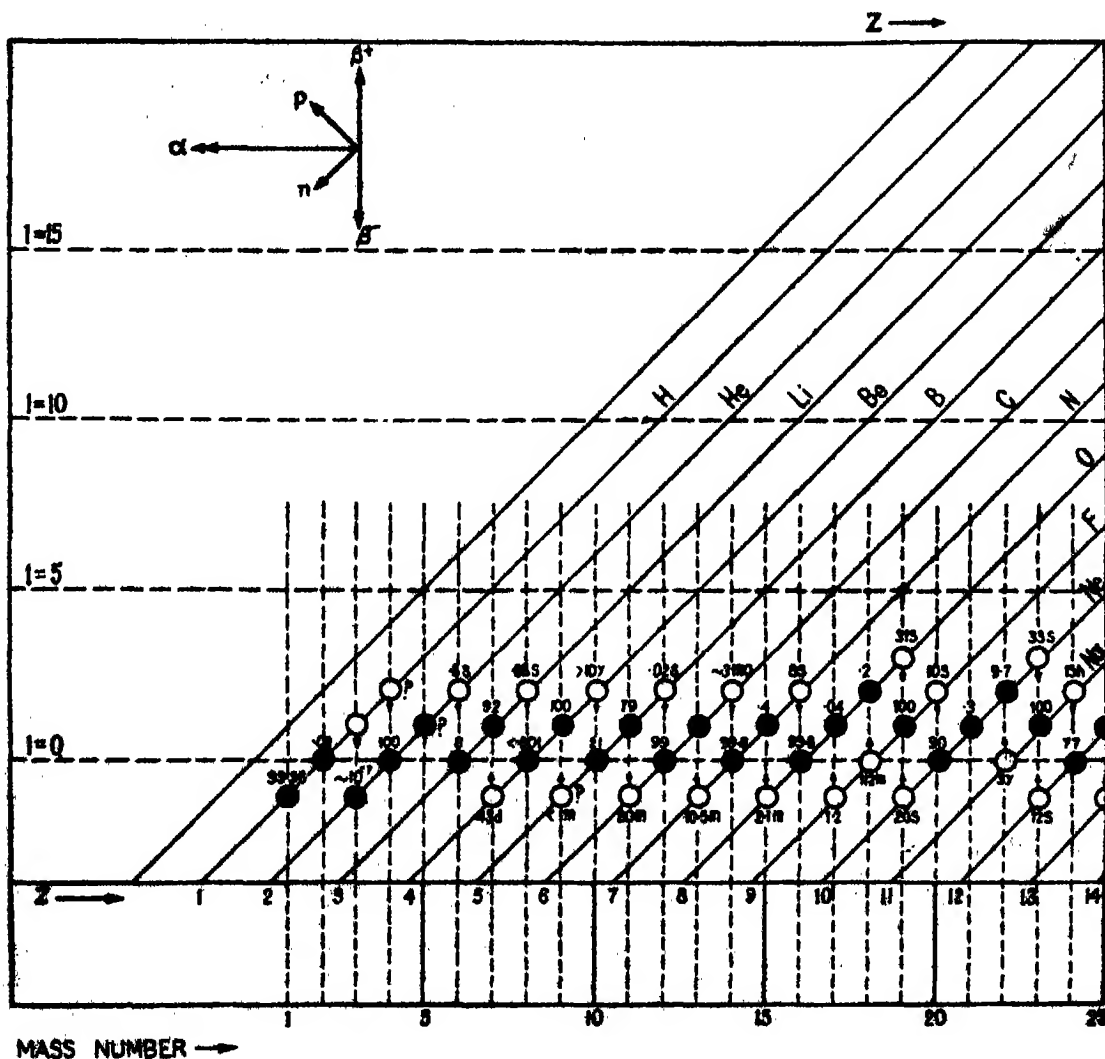


FIG. 2
LIGHTER ELEMENTS AND THEIR ISOTOPES

neutron, the white ones representing the proton. Some mysterious kind of super-electric force which is many million times larger than the familiar electric force but whose range of action does not extend beyond the nucleus, keeps the balls together. The nature and mechanism of action of these forces are now but vaguely understood.

The compositions of some of the lighter nuclei are represented in Fig. 2. Here the abscissa stands

numbers 1, 2, 3, 4. H^1 is simply the ordinary hydrogen, H^2 is the heavy hydrogen discovered by Urey a few years ago. Both of these occur in nature and are therefore stable. But H^3 and H^4 have been produced in the laboratory and are unstable. Both of them emit electrons and change to stable nuclei of He, of weights 3 and 4 respectively. The solid circles represent stable isotopes, the hollow ones those produced artificially.

A glance at the diagram shows all the isotopes of an element, stable as well as artificial ones, as far as known. Thus, oxygen has so far been found to have five isotopes viz., O^{16} , a new atom of oxygen artificially produced in the laboratory, which emits a positron and becomes stable N^{15} (the process is indicated by an arrow pointing upwards), O^{16} , O^{17} , O^{18} are stable varieties met with in nature, O^{19} is an unstable variety which has been produced in the laboratory and has a life of 31 seconds and changes to stable F^{19} after emitting an electron. These artificially produced unstable nuclei are the chief subjects of our concern in this article. Let us see how they are made.

Our starting point is some variety of atom available in nature. We subject it to bombardment by nuclear particles like protons, neutrons alpha-particles, and deuterons. Most of the projectiles go astray, but a small proportion, which increases rapidly with the energy of the bombarding particle, find their way to the nucleus. It then produces 'A Nuclear Reaction'. We have smuggled a new unwanted particle or set of particles into the *Sanctum Sanctorum* of the atom, which naturally causes some disturbance there. This cannot be allowed to go on, hence after a short time a new order sets in.

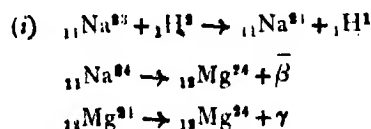
First, the new order may amount to the expulsion of a proton, or a neutron or some combination of them like the alpha-particle from the composite nucleus giving rise to a new type of nucleus. A few typical reactions are illustrated below :—

- (1) ${}_4\text{Be}^9 + {}_2\text{He}^4 \rightarrow {}_6\text{C}^{12} + {}_0\text{n}^1$
- (2) ${}_6\text{C}^{12} + {}_1\text{H}^2 \rightarrow {}_6\text{C}^{13} + {}_1\text{H}^1$
- (3) ${}_5\text{B}^{11} + {}_1\text{H}^1 \rightarrow {}_4\text{Be}^8 + {}_2\text{He}^4$

The symbols require some explanations. In (1) we have taken a beryllium atom of mass number 9 and nuclear charge 4 (ordinary beryllium). When we shoot at it with an alpha-particle of mass number 4 and nuclear charge 2, a neutron is expelled and we have a new system with 6 protons and 6 neutrons i.e., an ordinary carbon atom. In (2) a carbon (6 protons+6 neutrons) is shot at with a deuteron (1 proton+1 neutron), a proton is expelled and a new carbon atom of 6 protons and 7 neutrons is formed. This latter carbon is a rare but stable isotope of ordinary carbon. Similarly in (3) a boron atom of 5 protons and 6 neutrons is bombarded with a proton, an alpha-particle is expelled and a new atom, beryllium (4 protons and 4 neutrons) is formed.

Secondly, there may be in the product nucleus too large a proportion of protons or neutrons consistent with stability. At that stage some protons

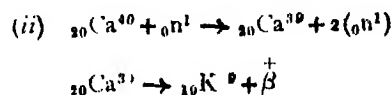
in the nucleus may change into a neutron, emitting a positron from the nucleus; or a neutron may change into a proton, emitting an electron. In this case the element has become radioactive, like radium or to be more precise like RaE product of radium which gives out electrons only. These cases are of the greatest interest to us. The processes are illustrated below :—



Energy of γ -rays = 5.5 million electron volts.

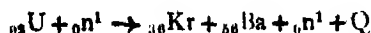
Mean energy of β -rays = 1.2 million electron volts.

Half life of ${}_{11}\text{Na}^{24}$ = 15 hours.



In (i) normal sodium atom (11 protons and 12 neutrons) is shot at with a deuteron. We get a new system having 12 protons and 13 neutrons. But this system is unstable and one proton is almost immediately expelled leaving us with a sodium atom of mass number 24. But such a sodium atom is not known in nature. It is entirely a new creation of man which we owe to the development of the technique of nuclear physics in physical laboratories. This ${}_{11}\text{Na}^{24}$ and hosts of other nuclei represented by hollow circles in Fig. 2 are not stable, but are radioactive just like radium. ${}_{11}\text{Na}^{24}$ emits an electron and is converted into a stable magnesium atom (12 protons and 12 neutrons). The expelled electron has an average energy 1.2 million electron volts which is comparable with the energy of electrons expelled from products of radium. It is found that the therapeutical properties of radium are due partly to β -rays expelled by some of its products. This artificial sodium can be used in place of radium and it will produce the same effect. The magnesium atom produced in this reaction is not however the normal magnesium, but it emits γ -rays of energy 5.5 million electron volts and become a normal magnesium atom. This can also be used for the same purpose as radium γ -rays i.e., for deep therapy work. In (ii) an ordinary calcium nucleus (20 protons and 20 neutrons) is bombarded with a neutron when 2 neutrons are emitted and a new type of calcium atom composed of 20 protons and 19 neutrons which is not known in nature is formed. The Ca^{39} is radioactive and emits positron giving rise to a new nucleus of potassium composed of 19 protons and 20 neutrons.

Thirdly, the nuclear bombardment may also disrupt the nucleus (fission) as illustrated below by an example:—



Here an uranium atom of nuclear charge 92 is bombarded with a neutron. A certain number of neutrons is expelled and the uranium atom is split up into two new atoms krypton and barium with nuclear charge of 36 and 56 respectively. Q is the energy liberated as a result of the disruption and it is calculated to be of the order of 200 million electron volts, the calculation has been also experimentally verified. This energy is shared by the two newly formed nuclei, which move off from each other with tremendous velocities on account of mutual reaction. This type of reaction has been discovered only a year ago and the reaction given above is only one of the large number of ways in which the uranium nucleus may be split up.

MANUFACTURE OF NEW TYPES OF ATOMS

Up to 1929 the radioactive property (power of emitting spontaneously high energy α -rays, electrons and γ -rays) was known to be confined to only to heavy elements beginning from lead and ending in uranium in general; though amongst the lighter elements, a few exceptions were known *e.g.*, potassium and rubidium were known to emit small-energy electrons. Thanks to the development of nuclear physics technique, hundreds of new radioactive nuclei have been produced in the laboratory, emitting electrons, positrons and γ -rays.

The reader may be under the impression that this gives us a cheap method for replacing radium. But actually it is not so. We can produce half a gram of radioactive sodium after a day's work with the cyclotron and this may cost us about Rs. 100. On the other hand half a gram of radium will cost us nearly Rs. 50,000. But radium has got a half life of 2000 years *i.e.*, if we buy today one gram of radium, it can be used for about 2000 years. But radioactive sodium has a much shorter period of only 15 hours *i.e.*, it can be used, roughly speaking, for a day only. Some other artificially radioactive body *e.g.*, phosphorus has longer life. But then the longer the life, the less intense the rays emitted from the atom. It appears therefore that the use of radium for therapeutic purposes will continue despite the appearance of new laboratory-made light radioactive bodies, unless in future, some new type of radioactive atom is found which may combine many of the desirable features.

'TAGGED' ATOMS AND MOLECULAR BIOLOGY

But the greatest use to which all these cyclotron-made radioactive atoms will be put is probably for

the purpose of tracing the course of chemical and physiological reactions. Suppose we give to a man a dose of some drug or foodstuff, containing sodium; the sodium which has been subjected to bombardment by neutrons or deuterons from the cyclotron and has been partly changed to radioactive variety, Na^{24} . Then the atoms distribute themselves within the human body, in the stomach, kidney, arteries and veins etc. After about 10 minutes sufficient radio-sodium reaches even the palm of the hand and it is found that if the palm is held near a Geiger Counter, an apparatus which can detect individual beta-particles or gamma-rays, it is affected. We can also find out the amount which has reached the palm of the hand. Supposing we administered 5 milligrams of phosphorus. This contains about 10^{20} atoms of phosphorus. When we subject it to the bombardment of particles from cyclotron, about a millionth part of it *i.e.*, 10^{14} atoms are given the hall-mark of radioactivity which decay with a half-life of 14.5 days, after emitting electrons. If a millionth part of that reaches the hand and if we take a sample of blood from it, it may be expected to contain about 10^5 atoms of radio-phosphorus. Now, it is found that in one second the number breaking will be about 100. So we shall have about 100 beta-rays and gamma-rays emitted from a drop of blood. This can be easily detected by means of the very sensitive apparatus known as the Geiger Counter which can detect even one single charged particle.

It is clear that these 'tagged' atoms can be used as tracers for finding out the course of a biological reaction and the way in which a drug distributes itself amongst the different organs. We can use not only radio-phosphorus and radio-sodium but also many other artificially active bodies.

These radioactive isotopes as indicators have already thrown much light on many problems of biological and chemical processes and more will be soon forthcoming. Only a few of them are mentioned here. Von Hevesy, the pioneer worker in this line, administered some radio-phosphorus into the diet of a rat and killed it after 10 hours. The different tissues of the animal were then analysed by bringing them near the Geiger Counter. The very important fact was brought out that the hardest tissues like bone and teeth which are made of insoluble salts and are at a considerable distance from the blood vessel, have exchanged with the radio-phosphorus atom from tissue fluids and blood. The phosphatides of the brain was also found to contain radio-phosphorus. Now it is known that phosphatide molecules take no part in simple exchange processes. Therefore, this radioactive phosphorus atoms can only have entered these molecules during their synthesis. Hence from the presence of radioactive phosphatides

in the brain tissue of a fully grown rat after the intake of a salt containing radio-phosphorus it was concluded that these tissues contrary to general expectation are constantly regenerated. Again it is of considerable medical importance to investigate the distribution of heavy metals in the fluids and cells of the human body in connection with poisoning by heavy metals and the therapy of syphilis and tumours. H. H. Khan investigated the distribution of bismuth in healthy and tumourous mice, using radium E as the indicator. He found that tumourous tissue retained the bismuth stubbornly while the others rapidly eliminate it. It is an important fact that a radioactive substance like radium E is selectively absorbed by the cancer cells, which again are particularly sensitive to its radiation. Some of the biologists are also trying to understand the mysterious actions of body catalyst such as haemoglobin, cytochrome glutathions etc., by the help of the indicator method. These catalysts are not yet synthesised. But it is possible to introduce some radioactive substance in them by chemical exchange when the function of these catalyst can be traced easily by a Geiger Counter. Probably the day is not far distant when the Geiger Counter will be used for biological investigations as frequently as a thermometer.

THERAPEUTIC ACTION OF THE NEUTRON

Hard X-rays and radium have long been used for the treatment of cancer. It is generally believed that it is the gamma-rays (which are only hard X-rays) from radium which act on the cells, they produce ionisation by the process known as Compton-effect and it is the Compton electrons which do something to the cells. Let us see what effect can be produced by the neutrons. When a stream of neutrons passes through anything containing hydrogen, it releases protons i.e., charged nuclei of hydrogen. These are expected to be much more powerful in their action on tissues than a stream of electrons released by gamma-rays. The effect of neutrons is in fact rather curious. As it is a nuclear particle, it can pass through several feet of lead without any diminution in its intensity and is stopped only when it encounters a nucleus, which chance is 1 in 10^8 and then it loses a very small part of its energy and can pass further on. But towards substances containing hydrogen like paraffin, it behaves in a curious way. As its mass is very nearly the same as that of the proton, on an encounter with the latter it parts with half its energy. While passing through a mass of paraffin about 20 cm. in thickness, 10 million volt neutrons will suffer nearly from 20 to 30 collisions with proton nuclei and will part with all its energy. It will produce in its track 20 high-energy protons and will itself be reduced to rest. Lead which is used as protective armour against penetrating X-rays

is useless in this case. To protect the worker against a stream of neutrons, therefore, we must use a double-walled mantle filled with water or paraffin of about a foot thickness.

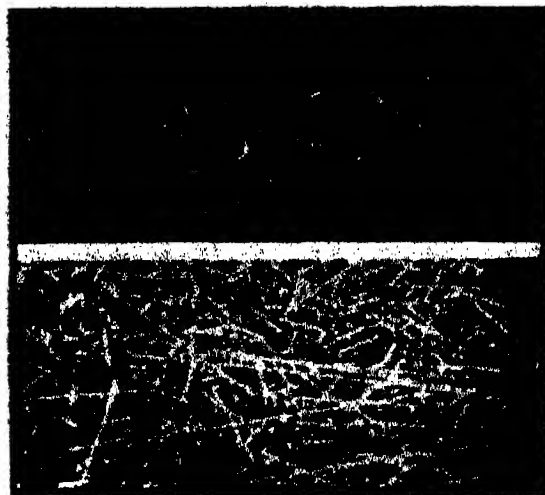


FIG. 3

The difference in biological action between X-rays and neutrons is illustrated above. The upper figure made by C. T. R. Wilson shows the tracts of electrons ejected from atoms in a cloud chamber by X-rays while the lower one made by R. O. Lawrence shows the recoil protons produced by neutrons traversing a cloud chamber.

[From *Journal of Applied Physics*]

The biological action of neutrons has been found to be quite remarkable. It is found that when cells are irradiated by neutrons they produce almost the same effect as X-rays or gamma-rays from radium, but the effect appears to be much more pronounced. The number of investigations so far carried however is not so great as to enable one to come to any definite result.

I have indicated in a very brief way the possibilities of molecular biology opened by the great work of Lawrence with cyclotron. You might ask why cyclotron is not installed in every medical college or hospital. This is because all million-volt generators, particularly the cyclotron, are extremely complicated and costly apparatus. From enquiries made during my visit to America in 1936, I found that a cyclotron capable of giving 5 million-volt protons will cost about 30,000 dollars in material, another 30,000 dollars for making and assembling the parts and will further require an annual recurring expenditure of about 4000 dollars for maintaining the staff. If any hospital wants to install a cyclotron, it will have to get an endowment of about 5 lakhs of rupees. But the prospects which are held out for a successful attack on tropical disease are so bright that the expenditure of this amount of money being far from being a luxury will be considered a great benefaction to humanity.

Research Notes

The Radio-frequency Spectra of Atoms

It is well known that the ground states of many atoms consist of a set of closely spaced energy levels owing to the interaction of the nuclear magnetic moment with the magnetic and electric fields of the electrons. The spin of the nucleus can be found out from the number of components in the hyperfine structure of the level and the magnetic moment from the separation of the different components of the hyperfine structure multiplet from each other. The resultant total angular momentum F has thus different values and the corresponding energies of the atom are slightly different from each other. There is some possibility of the transitions from any state F' to the lowest state F and the atom radiates in that case a quantum such that $h\nu = W_{F'} - W_F$. The value of ν depends on the separation of the hyperfine structure components and for atoms like Li^6 , Li^7 , K^{39} and K^{41} , it lies between 0.005 cm^{-1} and 4 cm^{-1} . This range corresponds to frequencies of radio waves of wavelengths ranging from 200 cm to 2.5 cm. These atoms thus radiate radio waves of the frequencies lying in the above range but the frequency being low, the probability of the transitions is very small, and consequently the radiation is too feeble to be observed experimentally.

Recently Kusch, Millman and Rabi (*Phys. Rev.*, 57, 765, 1940) have developed a method for observing these transitions between the energy levels of the hyperfine structure components of these atoms and also for determining very accurately the hyperfine structure separation and consequently the magnetic moment of the nuclei. The experimental method developed by them for studying magnetic moments by the molecular beam magnetic resonance method (*Phys. Rev.*, 55, 1939) has been used in the present investigation with slight modifications. The atoms are deflected in an inhomogeneous magnetic field, then pass through a homogeneous magnetic field and are again deflected in the opposite direction by a second inhomogeneous magnetic field to strike finally a detecting filament. The transitions from F to F' occur in the homogeneous field region where

an oscillating field of radiofrequency is situated and is at right angles to the homogeneous field. Transitions occur, when resonance takes place between the oscillatory field and the frequency of radiation emitted during the transition. Such transitions can cause a drop in the intensity of the atoms at the detector only if the moment of the atom in the second deflecting field is different from its value in the first. The transitions are governed by the selection rules for magnetic dipole radiation

$$\Delta F = 0, \pm 1; \quad \Delta m = 0, \pm 1$$

where m is the magnetic quantum number. In the limiting case, $H=0$, where H is the strength of the applied magnetic field, the transition $|F-F'|=1$ results in a single line. For any other value of H , a Zeeman effect of this line is observed. Such Zeeman patterns for K^{39} , K^{41} , Li^6 and Li^7 have been observed by the author and the magnetic moments have been measured. These agree with those derived from hyperfine structure measurements.

S. C. S.

Hyperthyroidism and Liver Function Related to B Vitamins

MANY authors have studied the alteration of liver function during hyperthyroidism. Frazier and Brown (*Trans. Amer. Assoc.*, for study of Goiter, 1935) reported the structural change of the liver and Maddock, Pedersen and Collier (*Journ. Amer. Med. Assoc.*, 109, 2130, 1937) could show its functional change during hyperthyroidism. Frazier and Brown (*loc. cit*) and John (*Jour. Amer. Med. Assoc.*, 99, 620, 1932) observed the depletion of liver glycogen during the clinical and experimental states. Since then it has been the custom to give a high carbohydrate diet to hyperthyroid patients in an effort to promote glycogen storage in the liver. Abelin and his co-workers (*Biochem. Z.*, 228, 165, 189, 1930) could show that large amounts of casein, egg-yolk or yeast would lessen the liver damage of the thyroid-

fed animals. Drill (*Jour. Nutri.*, 14, 335, 1937) however, was able to prevent the fall in the liver glycogen of thyroid-fed rats by feeding large amounts of yeast. Drill and Sherwood (*Amer. Jour. Physiol.*, 124, 683, 1932) observed that dietary requirements for vitamin B₁ and B₂ complex are above normal during experimental hyperthyroidism in rats. Drill and Hays (*Proc. Soc. Exptl. Biol. Med.*, 43, 452, 1940) have recently observed the same dietary relationship in dogs and they saw also that B vitamin deficiencies may not be the only factor

related to the production of abnormal liver function in hyperthyroid cases, but the production of abnormal liver function in cases of dogs bears a causal relationship to the yeast in the diet. They suggest that the subnormal amount of the B vitamins in the diet may be at least partially responsible for the abnormal function that is observed in the human hyperthyroid liver.

A. C. M.

GROWTH OF SCIENTIFIC RESEARCH IN INDIA

THREE stages can be perceived in the growth of scientific research in India. (1) The first contributions were made in connection with administrative needs—this led to the foundation of the scientific departments of the Government of India, viz., the Trigonometric Survey (1818); the Geological Survey (1845); the Meteorological Survey (1864) etc. (2) The next phase came with the recognition that teaching of science should form an essential part in the curriculum of schools and universities, and that university teachers should have ample scope for carrying on research work on basic sciences. (3) The third phase came with the tardy recognition on the part of the Central Government that scientific research is essential for national economy, particularly for agriculture and industries based on agricultural products (cotton, jute, sugar). The Government has not yet recognized that the large-scale industrial development is absolutely necessary for the solution of India's problems of poverty and unemployment, as well as for defence, but to anybody who has given serious thought to this subject, no other course can commend itself. The next phase in scientific research will commence when the Central and Provincial Governments recognize this fact, and embark on a policy of autarchy, i.e., production of all industrial goods, as far as possible, in this country, with Indian capital and labour. Such production will include many goods for which India has now to depend entirely or partly on foreign countries, e.g., textiles (cotton, silk and wool), railway materials (engines, wagons), motor cars and motor spirits, goods made of metals, glass, both heavy and fine chemicals, medicines and all offence and defence armaments. She will have to start industries which are now absent in India, viz., the power industry and shipping industry. For a successful realization of this policy, it will be necessary to mobilize all the scientific and technical talents of the country through the creation of a National Research Council.

—Science and Culture.

[The recent developments in the scientific activities of our country leading to the establishment of the B. S. I. R. compare very favourably with what we wrote in an editorial in the issue of July, 1938 (Vol. 4, No. 1)—Editor.]

BOOK REVIEW

Hindu Civilisation, (from the earliest time to the establishment of the Mauryan Empire)—By DR RADHA KUMUD MOOKHERJI, M.A., Ph.D., Professor of Indian History, Lucknow University. Published by LONGMANS, GREEN & Co. Pp. 319. Price 15s.

THERE is no doubt that the national awakening of the first quarter of the present century and the momentous archaeological discoveries made towards its close in Sind and the Punjab have considerably increased the interest of the average educated Indian in the ancient history of the Hindu civilisation. It must be, however, admitted that there is still a lamentable lack of useful and authoritative works written on the subject. The first volume of the *Cambridge History of India* to some extent supplied this need; but the book is not easily available in India, and it has become to some extent antiquated by the discovery of the Indus Valley Civilisation. A treatment of the subject, specially from the Indian point of view, was therefore needed and it is therefore in the fitness of things that Dr Radha Kumud Mookherji of Lucknow University should have attempted this task in his recent publication, '*Hindu Civilisation*' (from the earliest time up to the establishment of the Mauryan Empire).

The author has observed in the preface, 'The task of writing such a work has been considerably lightened by the publication of the *Cambridge History of India*, to which my obligations are both general and specific'. It is therefore clear that the book does not lay any great claim to originality. It is however written from the Indian point of view and its treatment of the problems connected with the history of the Jainism and the Buddhism is more comprehensive than that of its prototype, and it gives us valuable studies of the civilization as disclosed by epics, the *Sātras* and the *Pāṇini*.

A book on hindu civilisation can be written either for the expert or for the general reader or for the university student. Dr Mookherji's book belongs to the last category; for he has observed in the preface that it was suggested 'by the needs of the study and teaching at the universities of a subject, which for the period dealt with is necessarily somewhat

nebulous, indefinite and sometime speculative and highly controversial'. It would however appear that at many places Dr Mookherji had the general reader rather than the university student before his mind; it is probably due to this circumstance that he has not adequately discussed the controversies connected with the home of the Aryans, the date of the *Rig-veda*, the interpretation and implications of the Boghaz Koi inscription, etc. The *pros* and *cons* of the different views advanced on these subjects would have been very valuable for the advanced university student; they would no doubt be felt as boring by the general reader.

The book covers only 319 pages but the information it imparts is really extensive. It reveals practically all the phases of the ancient Indian civilisation of the pre-Mauryan period, religious, social and economic life, dynastic history, political theories and administrative practices and conventions. After giving a brief account of the Stone Age, it discusses the Indus Valley Civilisation. The author's picture of this ancient civilisation, the discovery of which was due to that eminent Indian archaeologist, the late R. D. Banerji, is lucid and exhaustive. In the 3rd chapter the author deals with the geographical and social background of the history of the period and discusses principal features of India's geography that have influenced her history. He justly observes that in spite of India's vastness and variety, geographical factors have invested her with a unity, which has been always realised by her people, exemplified by their history and embodied in their culture and institutions. The treatment of this subject from the pen of the author of the *Fundamental Unity of India* is naturally masterly and convincing and well worth perusal at the present juncture when Pakistans, Dravidists and Achhutists are trying to rear their heads.

In the next two chapters, the author gives an account of the Vedic and later Vedic period. Here his treatment of the social, economic and cultural life of the age is quite satisfactory, but the political history and the religious life of the age is not satisfactorily dealt with. It is not in this place but in one of the sections of a later chapter, Chapter VI, that

the author deals with the data about the political history of this period supplied by the Pauranic tradition. The Vedic and Pauranic traditions have many points of contact ; the author himself observes, for instance (at p. 151) how kings Srinjaya, Chyavāna and Sudās of the Rig-vedic fame figure in the north Pāṇchāla dynasty of the *Purānas*. It would have been therefore better if the author had correlated the data of the Vedic tradition with the information supplied by the Pauranic literature in order to give a fuller account of the political history of the period. This task is no doubt beset with considerable difficulties, but has got to be attempted with the full consciousness that the resulting picture may not be quite flawless and complete in the present state of our knowledge and archaeological excavations.

The author's account of the religion and philosophy of the period is rather inadequate. He devotes only a couple of pages to describe the religion and philosophy of the *Rig-veda*. The bold, original and thought-provoking speculations of the *Upanishads*, which have evoked admiration both in the East and the West, have been hardly touched. In a book which claims to deal with the Hindu Civilisation from the Indian point of view, this is rather unfortunate. Probably the limits laid down by the author for his book and the practical needs of the M.A. history students of Lucknow University rendered a fuller treatment of this subject impracticable and unnecessary.

A picture of the Hindu civilisation as depicted by the *Sūtras*, the epics and the law books is given in Chapter VI. Here the treatment is both lucid and comprehensive and the reader will get an attractive panorama of the family and social life, literature and education and the economic and political conditions of the age. It is probably his anxiety to utilise all the data supplied by the important works on Dharmaśāstra that has induced the author to devote separate sections to *Yājñavalkyasmṛiti* and *Nāradaśmṛiti* ; for both these works are centuries later than 325 B.C., down to which period only the author had intended to bring down his narrative as disclosed by the title.

The last chapter of the book, Chapter VII, deals with northern India during the period c. 650 B. C. to 325 B. C. The historical and literary material for the reconstruction of the history of this period is relatively more ample, and so this chapter is naturally the longest in the book. Full justice is done to the dynasties of the age and their feuds and ambitions, to the religious reformers and their preachings and proselytizing activities, and to famous teachers and their educational activities. The account given of the working of the democratic procedure of the contemporary republics is particularly illuminating and

enables the reader to have a clear idea of how the meetings of the assemblies were held, how the members were seated, how the debates were conducted, how complicated matters were referred to sub-committees, how votes were taken and how the proceedings were recorded.

Considering the wide range covered by the book, it was but inevitable that it should contain a few statements which should be incorrect or misleading. Attention may be drawn to some of them. At page 73 the author observes, 'The right of adoption was recognised' in the Vedic age. This may lead the reader to think that the adoptive son was at this time the normal substitute for one's own son ; the fact however was that the adoptive son was intensely disliked by society in the Vedic period, and the usual substitute for one's own son was a son by *Niyoga*. At page 86 the author states that the fundamental educational method of the Vedic age was *tapas* or the practice of penance and austerity as a process of self-realisation. This may lead the reader to believe that the young boys of the Vedic age used to devote the prime of their life to austerities. Such however was not the case. Asceticism was at a discount at that time, for the usual prayer of a Vedic hymn is for more sons, more cattle, more possessions. On page 131 *svadāravṛtti* has been explained as marrying in the same caste or always remaining in the householder's state ; the expression really means, remaining faithful to one's wife.

Inaccurate statements like the above are really very few in the book. It may be therefore confidently recommended to the student as well as the general reader for the purpose of getting a lucid, reliable and authoritative account of the Hindu civilisation, written from the Indian point of view and yet with strict impartiality.

A. S. Altekar.

Modern Ideal Homes for India—by R. S. Deshpande. Published by the author at Saraswat Brahmin Colony, Poona No. I. Pp. 319. Price Rs. 8.

Mr R. S. Deshpande has made a very good study of the housing problem in India and has already published several excellent books on this subject. His latest contribution is particularly valuable, because he has included in it much useful material gathered during his recent tour to the Western countries and Japan.

The first half of the book is devoted mainly to an analysis of housing requirements such as the selection of site, orientation, planning etc., and the second half deals mainly with information about buildings already built or projected including numerous illustrations.

The descriptive and analytical part is perhaps more valuable to the prospective house-owner inasmuch as it brings before him the various factors to be considered in the preparation of the general plan. This information should enable him more clearly to state his requirements to the architect or engineer, whom he may call upon to act as his expert adviser. It is not seldom that the average house-owner fails to visualize his own needs and to state them clearly before and during the preparation of the detailed plans for his building with the result that the completed building is sometimes found to be inadequate to meet his needs or to reflect his own individuality.

As regards the illustrations and particulars accompanying the 95 typical plans in the second part, it appears that they can only furnish but a very hazy idea to a person not acquainted with the design of houses. The particulars given are not sufficient enough, to discard entirely the services of a competent architect or engineer, before the work can be entrusted to a contractor. Some of the designs are open to the criticism that they are either not modern or not ideal for Indian conditions. The value of this part of the book cannot therefore be regarded as very great, either to the person thinking of building his own house or to the expert architect and engineer.

On the whole however it must be admitted that this book is a valuable contribution to our scanty knowledge on this subject and can therefore be recommended to the general public.

A. Pandya.

An Elementary Text-Book of Zoology for Indian Students—by DR B. L. BHATIA, D.Sc., F.Z.S., F.R.M.S., F.A.Sc., F.N.I. Third Edition. Published by Macmillan & Co., Ltd., London, 1940, Pp. xii+655. Price Rs. 8.

Dr B. L. Bhatia's *Elementary Text-Book of Zoology* needs no introduction to Indian teachers and students of the subject, since it has already served their needs in an admirable way for the last two decades. It was adapted, by substitution of Indian for European types so far as possible, from "An Elementary Course of Practical Zoology" by Profs. T. J. Parker and W. N. Parker so as to serve the needs of the Indian students taking up Zoology in their Intermediate studies. In the third edition advantage seems to have been taken to revise the text thoroughly and to eliminate the few minor faults that had been noticed in the earlier editions. Several new types have been added so as to cover the syllabuses of all Indian universities and Intermediate Boards; the students can thus select for study what is prescribed for them. Other important features of the new edition are that the general surveys at the end of the classes and phyla dealt with have been enlarged, new matter has been added on the importance of entomology and the role played by useful and injurious insects in the general economy of human life. To make room for this valuable additional matter, "Practical Directions" have been deleted throughout. This is in a way unfortunate as students have thus been deprived of the excellent directions for the practical investigations of the various animal types.

Besides enabling a student to pass the Intermediate Examination, the book has also a much wider appeal. The text is throughout lucid and fully illustrated. The get-up is very pleasing and the price moderate, and the author and the publishers deserve the thanks of the Indian students of zoology for the production of a book of this nature.

S. L. Hora.

LETTERS TO THE EDITOR

Factors Influencing Adsorption of Moisture from the Moist Air by the Soils

In order to study the adsorption of moisture by the soils under various conditions from the moist air, a very simple apparatus has been devised in our laboratory. By applying Prof. J. B. Seth's method¹ for production of dry or moist air currents of any desired percentage of humidity, humidity is maintained constant inside a chamber. A small quantity of soil in a dish is kept inside it at almost a normal pressure, which is read by a mercury manometer. After keeping it there for a known period, the adsorption power of the soil is calculated. The effect of rapid flow of the current on the soil is avoided by connecting this chamber with another similar chamber. The latter chamber is connected with the exhausting pump. The humidity is recorded by a tested and calibrated hair hygrometer in the first chamber and for its verification a wet and dry bulb hygrometer in the second chamber is kept.

The method has advantages over the other methods² where the soil is kept either outside in the open field or inside the Lovoured screen. In both the latter cases, variation of humidity is at the mercy of weather, observations have to be extended over a long period, a great range of variation of humidity is not possible and there is possibility of dust or smoke particles which are more or less always hanging in the air, depositing on the sample of the soil.

With the above mentioned apparatus the absorption of moisture from the moist air by the Patiala soil has been investigated under various conditions in this laboratory, and the following results have been arrived at:

(1) Adsorption of moisture from the moist air by any variety of soil increases with the relative humidity of the air. The rate of increase in weight is comparatively high at the beginning but slower later on. Thus the rate of increase slowly decreases with the increase of relative humidity.

(2) The amount of moisture adsorbed by the soil increases with the thickness of its layer. The upper layers adsorb much more moisture than the lower layers of the same thickness. The rate of adsorption regularly goes on decreasing with the depth of the layer from the upper surface which is exposed to the moist air.

(3) Adsorption increases with time but the process of adsorption is rapid in the beginning and regularly slackens on as the time elapses. In other words, the rate of adsorption decreases with time. The amount of moisture adsorbed from the moist air is directly proportional to the logarithm of the time for which the soil is exposed to the moist air.

(4) The amount of moisture adsorbed from the moist air decreases with the size of the particles of the soil and with the relative amount of the groups of particles (clods) in the soil.

(5) Adsorption of moisture from the moist air by the soil also depends upon the nature of the soil which depends upon the chemical constituents of the soil.

The details of the results obtained above which throw light on the work done in the past will appear elsewhere in due course of time.

The author is indebted to His Highness' Government, Patiala for providing facilities to carry out this work in the Physics Research Laboratory of the Mahendra College, Patiala.

Physics Research Laboratory
Mahendra College,
Patiala, 25-6-1940.

L. D. Mahajan.

¹ Seth J. B., *Nature*, 128, 638, 1931.

² Ram Das L. A. and Kati M. S., *Current Science*, 3, i, 24, 1934, and 3, 612, 1933, and *Ind. Jour. Agri. Sci.*, Vol. 24, part iv, 1936.

Ram Das L. A. and Mallik A. K., *Current Science*, Vol. vi., No. 9, 1938.

A New Sensitive Colour Reaction for Sterols and Steroidal Compounds.

Several colour reactions have been developed from time to time for detection as well as quantitative estimation of sterols which occur in nature either in the plant or animal kingdom. Though Liebermann-Burchard test and Salkowski's reaction are applicable to all sterols, other reactions (*e.g.*, those of Kahlenberg, Rosenheim, Tortelli-Jaffé) are supposed to be specific for ergosterol or some of its derivatives only.

It has now been possible to develop a new sensitive colour reaction which is applicable not only to all sterols (cholesterol, ergosterol, etc.), and their derivatives but also to the steroidal compounds in general, with characteristic peculiarities for each of the individual groups of substances, *e.g.*, sterols, bile acids, vitamin D, etc., and the name "Universal colour reaction for the steroidal compounds" has been proposed for the reaction.

The reaction consists in pouring carefully a few drops of concentrated sulphuric acid to a mixture of acetic acid solution of the substance and a special reagent (saturated solution of mercuric acetate in glacial acetic acid), when a brilliant brown, red or violet ring—according to the nature and concentration of the substance—is formed in between the two layers, and a blue or green ring is seen to be formed immediately above the former ring. The blue or green colour gradually extends upwards and makes the upper turbid layer coloured. The reaction is very sensitive and answers well even with a solution containing 0.02 mg. of sterol per c.c.

Details will shortly be published elsewhere.

Physiological Section,
Chemical Laboratory,
Dacca University,
Ramna, 16-7-1940.

M. C. Nath.

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Drug Control in India

A LONG with the progress of scientific civilisation, the art of medical treatment which has been practised empirically during all the ages has steadily burst the bounds of empiricism and has largely developed into a science. Today the scientific system of medicine is prevalent in a great part of the world, though in the less progressive countries the age-old regional systems are still popular with large sections of the people. In India, the Ayurvedic and Unani systems have considerable allegiance and have frequently demanded recognition as scientific systems. But there cannot obviously be two different scientific systems and the best course would be to accept the Western scientific system as the core and enrich it with such knowledge from Ayurvedic and Unani sources as can stand strict scientific tests. Public opinion in this country does not appear to be alive to the need of the control of Ayurvedic and Unani drugs, the composition of many of which is kept a secret. Very often these drugs are prepared by the prescribing medical men themselves and not by specialised manufacturers. But one good consequence of the development of medicine on scientific lines in Western countries has been that medical practitioners have specialised in the direction of diagnosis and treatment, while the preparation of drugs, which is exceedingly complex, has been taken up by manufacturers employing highly trained scientific personnel. This division of labour has resulted in great progress and phenomenal advances have been made during recent years by co-operation between medical men and trained scientists, specialising in

the preparation of drugs. At the same time in almost all civilised countries the State has found it necessary to control drug manufacture and drug trade and prevent the traffic in adulterated, under-strength and misbranded products in the interests of both the consumer and the honest producer.

In India drug production and drug trade are still uncontrolled. That for long years both the honest producers and the consuming public have suffered from this absence of control has been evident even to the casual observer. The extent of the harm done was crystallised in the Report of the Drug Enquiry Committee presided over by Bt.-Col. R. N. Chopra, which was submitted in 1931. After many years' delay the Government of India have now passed a Drugs Act, which can definitely improve the present position provided it is properly implemented *on right lines*. This warning is necessary. In this country many good schemes fail and even render more harm than good because they are wrongly operated or operated with wrong personnel.

The Drugs Act of 1940 is intended to regulate the import, manufacture, distribution and sale of drugs and it will have obviously far-reaching influence on every aspect of the drug industry and drug consumption in this country. It provides for the formation of a Central Drugs Technical Advisory Board and of a Drugs Consultative Committee representing the different provincial governments. Both provisions are sound. The first is essential for

framing uniform rules and standards, which require considerable expert technical knowledge, and for setting up the right kind of organisation for testing and analysing drugs and for all technical aspects of drug control. The second is necessary for the enforcement of the Drugs Act in the different provinces in a uniform manner. After the Central Drugs Technical Advisory Board and the Drugs Consultative Committee have met and framed their recommendations with due care, it will presumably be the duty of the provincial governments to set up provincial Advisory Boards for bringing into existence the provincial testing laboratories and keep control of the provincial drug trade generally. The whole machinery of drug control in this country will therefore depend on the formulation of correct lines by the Central Drugs Technical Advisory Board and by the Drugs Consultative Committee and on the organisation of the Central Drug Control Laboratory *on right lines and with proper personnel*. It is obvious that the discharge of such a grave responsibility requires very careful deliberation and adequate consideration of the measures adopted in other advanced countries for drug control.

The drug control organisation of the United States of America appears particularly suitable for careful consideration, because that country offers a good parallel to this country in several respects. India is populous and divided into provinces requiring inter-provincial regulations like the inter-State regulations in America. There is a uniformity in the enforcement of the different drugs, food, insecticide Acts, etc., in the United States, as the inspection and control are consolidated in one organisation called the Food, Drug and Insecticide Administration. This uniformity is relatively lacking in Great Britain, where, as the Secretary of the Pharmaceutical Society of Great Britain points out, the trade of chemists and druggists is affected by many statutes, for the enforcement of which different authorities are responsible. It is desirable that in taking concrete steps for drug control in India, we should aim at the uniformity that happily exists in America.

The organisation of the Food, Drug and Insecticide Administration of the United States is well worth detailed study. It can indeed serve as a general model to India, though it naturally will have to be adapted to local conditions. The Food, Drug and Insecticide Administration is responsible for the enforcement of several Acts concerning food and drugs, tea, naval stores, insecticides and fungicides,

milk and caustic poisons. The Administration is divided into three branches: (i) Executive Supervision, (ii) Technical Control and (iii) Field Service. There is a chief of the entire Administration who exercises supervision and control over all these branches and thus complete co-ordination is effected. The Executive Supervision Branch is responsible for administrative activities and has the following offices: (a) Office of Business and Informational Supervision, (b) Office of Insecticide Act and Caustic Poison Act Supervision, (c) Office of Import Supervision, (d) Office of State and City Co-operation, (e) Office of inter-State Supervision. The Technical Control Branch is responsible for regulatory activities and has got the following divisions: (a) Food Control, (b) Drug Control, (c) Insecticide, Fungicide and Caustic Poison Control, (d) Tea Control, (e) Naval Stores Control, (f) Special Collaborative Investigation. The Field Service Branch consists of the Food and Drug Inspection Stations, which are distributed over three Districts, called Eastern, Central and Western, each of which comprises several States in that particular geographical zone.

There is one feature of the above Administration to which attention may be drawn. Except where business, informational or purely administrative work is necessary, all the heads of the branches and of the subdivisions under the branches are chemists and also the majority of officers under the Administration are chemists. Although medical men were the first to introduce the world to drugs, the highly technical nature of drug manufacture has so developed that in all progressive countries technical posts concerning drugs are not held by medical men *qua* medical men but by trained chemists and pharmacists, who may or may not have medical qualification in addition to their technical qualification. In this country this aspect of the question requires to be emphasised as the association of ideas between medical men as such and the manufacture and control of drugs still persists. In this connection it may further be pointed out that in India there is still a confusion between the terms pharmacy and pharmacology, which is having its repercussion on the problem of drug control organisation. While pharmacy includes a certain amount of pharmacology (which relates to the biological action and assay of drugs), it mainly consists of pharmaceutical chemistry (which refers to the chemistry of the preparation and assay of drugs) along with pharmacognosy (or the identification of drugs and drug sources). In fact, the major portion of the preparation and assay of the drugs

mentioned in the official pharmacopoeia of all countries is entirely chemical in nature. A pharmacologist is thus not necessarily a pharmacist, although a pharmacist should know something of pharmacology or the methods of biological assay. It is therefore not strange that both in the Technical Control Branch and in the Field Service Branch of the Food, Drug and Insecticide Administration of U.S.A. the chief as well as the superior posts and also the larger number of posts are held by trained chemists and not by pharmacologists as such.

The question of the type of qualification necessary for efficient drug control work is exceedingly important, as the success or otherwise of the Central Drug Control Laboratory to be set up by the Government of India will obviously depend in the main on the appointment of the right type of personnel particularly in the chief and superior posts.

This personnel should possess exactly the right kind of technical qualification in order to inspire confidence in the minds of both the drug manufacturers, particularly the indigenous manufacturers, and of the consuming public.

We would congratulate the Government on their having taken up seriously the work of drug control. It is also good to have been assured by the Government that a Pharmacy Act which should really run *pari passu* with the Drugs Act is shortly going to be taken in hand. Without these two Acts working together it is not possible to have the best results from the present endeavours. And we trust that in formulating concrete steps for drug control in near future the Central Technical Drugs Advisory Committee and the Drugs Consultative Committee set up by the Central Government will take into consideration the observations set forth in this article.

THE TRUE MISSION OF THE RACE.

THERE is still a duty to keep the torch of pure science lit, and this duty is only the greater under stress. All the long struggle of a harsh evolution, the pitting of species against the environment, has produced a being whose primary distinction is conscious cerebration, and whose crowning attribute is his intellectual curiosity concerning his complex environment and a thirst for knowledge transcending the mere struggle for existence. If there is no abiding value in a Beethoven symphony, or a theory of the cosmos, or the tracing of an ancient culture, then the Carnegie Institution of Washington has scant reason for existence. If it is really good that man should look at the stars and should contemplate his great destiny, then it is imperative that in those regions which enjoy the blessings of peace the search for the eternal verities should continue.

The dual character of science influences much of our outlook. We look at the stars, and we build yet greater machines to aid our vision, for two reasons. The stars are a laboratory, wherein are pressures and temperatures far beyond those we can artificially produce; which we can merely observe and not manipulate. Nevertheless, through thus observing we have already learned many things which have advanced the science of physics and in turn its applications. All this is to be welcomed, yet it should not completely dominate our thought. We also look at the stars for the same reason that inspired the shepherd on the ancient hill, because we are bound to think of greater things than the comforts or dangers of the morrow, perhaps because thus, to inquire and to speculate is the true mission of the race.

—Report of the President of the Carnegie Institution of Washington, 1939.

America and Indic Studies

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IN America academic activity in Indic studies has been limited to a few universities, and this more toward linguistic research than toward effective presentation of the broad scope of Indic culture to the student world. American institutions can be proud, however, of this academic research. The names and work of Warren, Whitney, Hopkins, Bloomfield, and Lanman form a glorious chapter in the history of Indic studies.

However, India in the first half of this century has become headline news, not as a land of vague philosophies and abstruse tongues, but as a developing nation with a live culture. We in America have seen the need of a wider approach to Indic studies in educational work, without, of course, relaxing one bit the intense research in India's past, for there lie the deep roots of her culture. And many of these roots have not yet been traced to their tips.

The Library of Congress in Washington has long demonstrated under the vigorous leadership of its former Librarian, Dr Herbert Putnam, its vitality as a national centre for the organization and use of research and educational material in various fields, and notably in the Far Eastern field. Without committing itself to a definite programme the Library readily lent its assistance with private financial support to the survey of existing materials in American institutions for the pursuit of the study of Indian culture. First, printed books were completely listed wherever they existed in America, then manuscripts, and finally all museum resources and the use has been made of these materials in the curriculums of colleges and universities. It at once became apparent that the Library should become the centre for the exploitation of this material by making its use available to government officials, to scholars, to journalists, and to the public at large. With the financial assistance of the Carnegie Corporation of New York the development of Indic studies at the Library was begun two years ago. Students today are being prepared for life in the latter half of this

century when the Orient will be far more important to them than it has been to us. The survey of college instruction which has been mentioned made it apparent that there has been a neglect in American universities of the study of the Middle Orient—its history, religion and philosophy, its science, its warfare and its peaceful arts—which have so influenced our civilization that scarcely a college subject is untouched by it. We are asking whether we can afford to neglect in our educational scheme an area which numbers well over a fifth of the human race with a culture older even than the Egyptian.

There are at present seven large universities in America offering competent linguistic training in the Indic field. A few others offer something on the art, history, sociology, and philosophy. We feel that perhaps a half-dozen universities in addition must be encouraged to add courses in the languages of India. But by far the most important project will be that of interesting colleges and universities throughout the breadth of the land to include in their philosophy, economics, sociology, history, and fine arts departments an adequate treatment of the Middle East. The case has been admirably stated by my colleague, W. Norman Brown, as follows in his article on "India and Humanistic Studies in America": "Here in the West we still largely confine our humanistic studies to our own civilization. We are concerned with its roots—primitive, prehistoric, and historic—its evolution into its modern state, and the interrelationships of its subdivisions (British, American, French, German, Italian, Russian, etc.). Where the European-Christian culture has clashed with the Far Eastern, the Indic, or the Islamic, we have generally viewed the clash from the point of view of our own narrower prepossessions, with little, if any, comprehension of the reason why the Chinese, the Indians, or the Moslems of Arabia or elsewhere have acted as they have, and without taking a wider world-view, of the meaning of these clashes. We have satisfied ourselves with inspecting a single side of the medal, and have

assumed that we need not know the other; our history has only one dimension. To state the matter so—even with allowance for some degree of overstatement is to reveal its fallacy.

"It is a fortunate sign that agencies in this country which have at heart the promotion of knowledge for the good of all have in recent years been steadily increasing the amount of their attention to Far Eastern civilization, our cultural neighbour across the Pacific, with which we have close and dynamic contact. More attention than at present should also be given to Islamic culture and the peoples living by it today, in the Near East, and elsewhere in Asia and Africa.

"If trade were to be the extent of Western contact with India, we might not see in it alone a sufficient basis for studying her culture, but so narrow a view of our prospective relations with that country is unwarranted, as it is also in the case of the Far East. India's highly organized and relatively homogeneous civilization is bound to come in ever closer touch with our own; for as intercourse between remote parts of the world becomes increasingly easy, India's relative intellectual isolation must decrease along with her relative economic isolation. Her achievements in the art of living are at our disposal, as ours are at hers; her problems too will become ours as those of Europe and the Far East have been brought into our life. We shall need to reconcile our civilization and hers, to the change of both. For she can contribute to us, as we are now contributing to her."

The inevitable point of departure for the servicing of such a programme at the Library of Congress was the establishing of firm contacts with Indian scholars, culture groups and institutions, and with the sources of materials for study and research. Of course, we cannot hope to succeed in our work in America without the active and whole-hearted support of India. In eight months time I have received the needed encouragement from India. The material accomplishments so necessary for implementation of the work have been immense. And what is probably most important, the contacts made will become increasingly firm to the advantage of both the Americans and the Indians, at least in the cultural field.

From a recent report of the Library of Congress I quote: The universities and colleges of India are growing in size, numbers, and enterprise. They are

becoming increasingly important as publication centres. They display a marked tendency to supplement curriculums based largely on Western patterns with a new and rigorous study of Indian culture and achievements. It is evident therefore that these institutions are strategic points of contact between India and the Library. A number of contacts have been enjoyed in the past with some of the older universities. These will continue on an increased scale, and where fresh ground has been broken, real co-operation will materialize in the exchange of publications and the mutual use of resources to whatever extent possible.

The museums of India have for the most part suffered from a lack of funds. However, the Archaeological Department of the Government of India has been most generous in the disposition of antiquarian material. Further, many curators, in spite of the limited resources at their disposal, have by their individual industry frequently accomplished remarkable results. The already existing bonds between the Library of Congress and a few of the large museums have been strengthened, while additional institutions have expressed their willingness to co-operate with Indic studies at the Library.

The list of cultural organizations in India is legion. Many have enjoyed long years of fruitful service in research and publication. From these there has been universal expression of appreciation that there is now at the Library of Congress an American centre for Indic studies to which they can communicate information on their work, and in return be posted on the activities of American scholars and educators in the Indic field.

Exchange of publication has been arranged with the various libraries of India. Most of the libraries owning valuable manuscript collections have been enlisted in a plan to be described later under a discussion of micro-filming, which will afford American and Indian scholars considerably easier access to these valuable research sources than they have had in the past. It may be noted that the Bengal Library Association, the Madras Library Association, and the Indian Library Association are doing excellent work in standardizing and organizing library methods and expansion.

All of the important publishing firms and book-dealers have been visited or contacted. Their lists will now be sent regularly to the Library. In addition much bibliographical data on past publications

have been collected. As a result, the Library should be in a unique position to furnish all interested scholars, institutions, and laymen with accurate information on books published in India which deal with India. In view of the disorganized state of Indian publishers the maintenance of this service will be of the greatest value to all concerned. This work will complement the cataloguing and bibliographical plans at the Indic Studies department of the Library of Congress, which first centred about the Library's editions of the Tanjur and Kanjur, rare in the West. The Choni edition, unique in the West, has never before been catalogued. The completion of this catalogue will be a valuable contribution to Tibetan scholarship. Many works at the Library in the various languages and scripts of India and Greater India are being classified and catalogued for the first time. Plans are being developed for a complete classified bibliography of printed Middle Eastern material with a notation for each item of the publisher and whether in or out of print. The bibliography will be in the form of a card file which can be added to constantly and copied in whole or in part by the microfilming process. The co-operation of Indian scholars will be needed.

Several hundred books have been acquired for the Library in general and for the Law Library. Many of these are rare and of antiquarian value. Recent publications in modern affairs are also included. The complete list is a notable addition to the Indic collection at the Library and will greatly implement further research.

Several collections of old manuscripts in Sanskrit, Prakrit, Hindi, and other vernaculars have been purchased. The collections contain a number of manuscripts not listed in any manuscript catalogue. The printed catalogue of these manuscripts will appear in a supplement to the *Journal of the American Oriental Society*. The following are a few of the important items: *Vyavasthāsārasaṃgraha* by Rāmagovinda, *Dāyasāra* by Govindānanda, *Āśaucasaṃkṣepa* by Madhusundanavācaspati, *Kṛṣipaddhati* by Kapālabhṛt, *Ācārādarsa* by Śrīdattopādhyaya, *Tithitattva* by Raghunandana, *Rudrakalaśāsnānavidhi* by Nārāyaṇa Bhaṭṭa, *Rāmāyaṇa* with commentary by Maheśvara-tīrtha, and *Yāsasikā*.

Through the means of a survey made by the Indian Gramophone Company recordings presenting the various forms of Indian music have been purchased for the Music Division. The work done on this survey was exhaustive so far as the industry is

concerned, and I think that a unique collection of records for Western ears has been assembled.

Motion pictures and many stills have been taken. One of the cinema films pictures some of the very old Vedic rituals of the Malabar coast. These include a marriage and a tonsure ceremony according to the *Āśvalāyanagṛhyasūtra*. It is believed that this film document is unique. The motion picture film industry of India has been investigated. Several films will be recommended for acquisition and distribution by the Film Library of the Museum of Modern Art of New York City. This visual work again cottons with project now being launched by the Library of Congress in co-operation with the American Council of Learned Societies to survey Islamic and Indic resources in America for visual education, including slides, photographs of art objects and miniatures, maps, graphic ethnological material, charts, blue-prints, etc. An index is to be prepared at the Library and complete copies of the material in microfilm will be made. A visual archive of this type will supply a need long felt by educational institutions, which have in the past been unable to have more than chance knowledge of the existing materials in America for lecture and educational purposes, particularly in the field of oriental art and architecture.

As a result of visits made to officials of Indian States and provinces many official publications will now be available to the various United States Government bureaus and interested individuals.

More than six thousand pages of rare Indian manuscripts in Sanskrit and the dialects have been photographed by the microfilming process. These film records will be deposited at the Library of Congress. Among them are important ritualistic texts, rare Jain manuscripts, a rare manuscript of the *Vetālapañcaviṃśati*, and old Tantric texts. Arrangements have been made with the important manuscript libraries whereby further microfilm copies of manuscripts desired by American scholars can be easily secured. Microfilm facilities now exist at strategic cultural and geographical points in India including the machine at the Royal Asiatic Society of Bengal, so that all manuscript sources can be tapped. This developing service will greatly benefit Indian and American scholars alike, not only in making research materials more accessible, but also in preserving old and valuable documents from extinction.

To set forth some of the advantages to the scholars and to libraries of microfilm and of the international service now existing in America for the benefit of scholars everywhere, I offer some extracts from the reports of the American Documentation Institute or ADI in short:

The invention of printing was the first major advance in methods of documentation. In the early days of this republic, however, printing had already outgrown the means of knowing what was in print and where. Our early learned men maintained a running guide to printed research materials by constant correspondence among their own few members.

Our present world with its thousands of scholars, thousands of institutions, government bureaus and commercial research departments, and millions of printed pages, produces untold wealth in scholarly material, both original and adapted. This mass has far outgrown the means of finding it when published, and the means of publishing it.

The American Documentation Institute was created by important national scholarly groups to help them solve the problem. Having no matter of its own to publish, no journals to maintain, no institution to aggrandize, no profit to earn, it exists only to push the work of others out in front where those who need it may see it. It is constantly thinking about bibliography, publication, reproduction, circulation. No one-page scholar's note is too small, and no thousand-volume collection too large, to receive its help in getting somehow into the right hands.

ADI is not committed to any one plan or technique but uses regular printing, offset, blueprint and all the near-print methods cheapest and best for the particular case. Where a single copy or a small edition is needed and the need can be cheapest served thereby, it has its Bibliofilm Service to copy the material in the form of microfilm comfortably legible in a projector or reading machine, which is now commercially available but still about a third the cost of photostats, and readable without optical aid.

Bibliofilm Service is operated by ADI on a non-profit basis, with the best laid out microphotographic laboratories in the country, with three years of scientific pioneer development

costing some \$25,000 behind it, and with, to show for the struggle, one of the most technically expert staffs and the latest and most highly improved and efficient electrically operated equipment. It is in the fortunate position of being able to turn out work, which has passed beyond the experimental stage and attained a proven high standard grade, with a speed, efficiency, reliability, and hence economy, exceeding anything heretofore achieved.

ADI's Bibliofilm Service laboratories are operated in the U. S. Department of Agriculture Library, Washington, D. C., under a co-operative agreement with that Department, and its additional microphotographic copying cameras are installed in the Army Medical Library and the Library of Congress. One use of the installations thus serving these three great libraries, is to copy for scholars extracts from books and journals needed in their research. This copying is done at cost, the rates being a fixed charge of 20 cents, plus 1 cent per page for microfilm copying or 10 cents per page for photoprint.

Scholarly societies have at hand, in the further services of Bibliofilm Service which ADI has made available to the learned world, a means of publication without the cost which faces anyone who otherwise plans to print something, or near-print something in an edition, however small.

This is because publication is accomplished by the group's editor by merely depositing the matter with ADI, which lodges it in the custody of the U. S. Department of Agriculture Library where it is safe and immediately available, it is offered to the public through a journal; and orders for it are filled at its regular low cost rates by ADI, ordinarily by making a microfilm copy, or photoprint copy, but equally well by furnishing any other sort of copy, such as full-size black-letter-on-white-paper by a new photographic process, as may be ordered by the scholar or library wanting the material.

This Auxiliary Publication Service is available to the editors of journal in any field, without cost to the editor, the journal or the author. It enables the journal to publish more or longer articles without spending more money. It enables the author to tell the whole story without

being held to five, ten or any limited number of pages. It enables the publication of unlimited pages of tables without the cost of that expensive sort of special compositions. It enables the publication of photographs, graphs and charts without the cost of cuts. It enables the journal editor to demand, as several learned societies are insisting that he should demand, that the author should furnish with the article all the basic data, working papers, full or supplementary text, illustrative and supporting matter upon which he based his conclusions.

This is the way the Auxiliary Publication works in the case of a paper submitted to a journal, proceedings, transactions, bulletin or compiled publication series. The author submits to the editor the complete contribution. The editor alone decides (1) whether he will publish it at all; (2) how much he will print and (3) how much he will issue through ADI. Having decided to publish the contribution, the editor divides it as he prefers. He may: (a) print the whole contribution, *i.e.*, all the text and all supporting data, when nothing is issued through ADI, (b) print the summary only, together with a note stating that the complete paper is available from ADI as Document No. —, at a cost of — cents in microfilm or — cents in photoprint, (number and price being notified to him by ADI, see below), and (c) print all the text of the paper, together with a note stating that the supporting data is available from ADI as Document No. —, at a cost of — or —.

In both the latter cases the editor forwards that part of the contribution, which he has decided to issue through ADI, to ADI giving the title, author, and the issue of the journal in which the matter which he has decided to print will appear. If he does not yet know in which issue he will print the contribution, he may send the matter at once and advise ADI of the issue later. ADI receives the matter on permanent deposit, gives it a Document Number and fixes the price for a copy, according to its regular copying rates, and at once advises the editor of number and price.

Reprints of the matter deposited with ADI may be obtained by the author in unlimited number from ADI at its usual cost rates, either in microfilm or photoprint. Or if the author wants to order a definite number reproduced by

printing, or any of the modern methods such as offset printing, blueprint or black-on-white print, ADI will be glad to make such an edition for him on a non-profit basis.

Auxiliary Publication is also used apart from journal articles. It is available to an institution or scholarly society for the publication of monographs, books, reports, studies, bibliographies, sets of specimens, sets of X-ray photographs, or any other results of their work.

The original matter is deposited with ADI by the society or institution, and the latter makes known its availability by notice in the journals of the group, bulletin, circular announcements, each reference giving the document number and cost of a copy in microfilm and in photoprint. The reader desiring a copy orders it direct from ADI.*

* The following quotation from the statement of the American Documentation Institute will be of further interest.

In only one instance is an entire bibliofilm library planned, that being a library to be developed from scratch.

For the going library, the role of a bibliofilm collection is to supplement the printed accessions. Four separate purposes are served:

- A. To fill volume gaps in existing sets.
- B. To augment the library's completeness by adding bibliofilm sets of the rarer and more wanted journals.
- C. To increase the permanence of the library's holdings.
- D. To improve documentation for research.

A. Within the library such bibliofilm volumes are accessioned in the same manner as printed items and entered on the title card of the serial. When a call slip is put for such a volume, the bibliofilm is delivered at the central desk instead of a printed book, and the reader is directed to a reading machine, where either he or a staff member puts the roll on the machine.

B. Adding Bibliofilm Journal Sets. Of much greater importance than odd volumes is the present opportunity offered by the initiative of the American Documentation Institute with the aid of a limited grant, under which the non-profit Bibliofilm Service is permitted for the time being to fill orders for bibliofilm copying sets, *i.e.*, any properly copyable 10 or more consecutive volumes of a serial scientific or learned periodical, set of year-books, memoirs, transactions, proceedings, etc., at a special rate of $\frac{1}{2}$ cent. per page.

This effort is not confined to any arbitrary list of titles. The library knows best its own pressing needs. The survey made under a grant from the Committee on Scientific Aids to Learning developed however a list of fundamental journals widely lacking and widely desired by libraries. Inquiries and orders received, while including many other items as well, have centred heavily on the journals so listed.

C. Increasing the Permanence of the Library's Holdings. American librarians, who easily lead the world in techniques of their profession and in scientific knowledge of paper, binding, and preservation, are aware that the

Microphotographic copying services exist to a gradually increasing extent, in London, Paris, Berlin, Rome, and other European cities, Latin America, Japan, India, etc., and Biblionfilm Service maintains relations with these services. Copying orders received by Biblionfilm Service for material not in the United States are filled through such foreign sources for biblionfilm users. International standards are encouraged to the end that material, size, orientation result in microfilms usable on the standard equipment in vogue.

bulk of the learned and scientific journals are on impermanent paper.

In examining thousands of these volumes, the Biblionfilm Service has found that they already show signs of decay and disintegration. There will come a time, not far off for some of them when no matter how many copies on the original paper are held in no matter how many places, they will all, approximately simultaneously, crumble to dust.

According to a scientific study made by the Bureau of Standards, microfilm properly processed and kept has a life equal to that of pure rag paper, which we know has already lasted some centuries.

When the expensive bound sets go, therefore, along with those of all other libraries, the biblionfilm sets will still be serving research.

The American Documentation Institute in providing this effort is interested in helping libraries augment their holdings, in improving documentation for research, and also in our duty to hand on intact to the future the record of scientific and learned achievement up to now.

D. Improving Documentation for Research. The ADI survey brought out an interesting fact, namely that there are two separate categories of the rarer journals used for research:

(a) A list of about 3000 journals, to which references are spasmodic. No library has, or can have, them all. The practice is to obtain for the research reader the extract desired—usually from 1 to 15 pages—by an order for biblionfilm extract copying. The Biblionfilm Service alone is filling extract orders to the amount of 20,000 pages per month, covering an enormous range of journals.

(b) As against the above 3000 journals, a small list of a few journals, not more than about 40, which account for 20 per cent of all use.

They appear in the abstracting journals several hundred times as frequently as the others.

They are constantly in use in the few source libraries which have them constantly out on loan to divisions, frequently in the bindery for repairs, hence constant delays in availability for copying. Because of constant need for use, interlibrary loans are not permissible.

For these few journals the method of copying from others' distant volumes whether by hand, photostat or microfilm, no longer answers. These few journals must be in the places where research is done.

The Address of American Documentation Institute is
Care Offices of Science Service, 2101 Constitution Ave.,
Washington, D. C., U. S. A.

Indian scholars and institutions can make use of this service and gradually build up something similar within India. The nuclei of such a service have already been established. The Royal Asiatic Society of Bengal stands ready to do its part with the equipment and facilities now at its command. Mutual benefits on an exchange basis with ADI and the Library of Congress will soon be forthcoming. I have demonstrated the equipment everywhere in India, and it is to be expected that whatever institutions now have such equipment will co-operate in assisting each other and the scholars of India. The great advantage of microfilming is the speed and cheapness of copying. The machine set up at the Royal Asiatic Society of Bengal when operated by one person is capable of photographing on 35 mm. film 120 pages per hour at a cost of from $\frac{1}{2}$ to 1 anna per page. The negative can be read by means of the magnifying reading machine or can be enlarged in a positive reproduction.

It is the hope of those Americans interested in spreading the study of India in America that microfilming will greatly facilitate their programme. But this is only a part. I have already referred to plans to add to the number of those colleges and universities in America which now offer work in Indian languages and culture. Further, it is expected that one day an American school will be established in India to which young Americans may come to study and do research. Similarly it is hoped that the services of Indian scholars can in the future be more widely used in America. All these measures must inevitably lead not only to an increase in the volume and quality of Indic research, but more important, also to a new and reasonable conception among Americans of India's role in the history of the past and her importance to the world of the future. Such an understanding must be attained by the Americans not through the sporadic and temporary adoption of "spiritual" fads, nor through the zealous and colourful efforts of journalism, but through the slow, steady processes of intelligent study and clear evaluation. Only so can this understanding be not a pastime, but a tool and guide for the future.*

*Lecture delivered at the Royal Asiatic Society of Bengal on July 31, 1940.

Artificial Fertilizers in Indian Soils

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INTRODUCTION

THOUGH recently a great deal of information has been gathered on the manuring of Indian soils, much has yet to be learnt about manures and manuring under Indian conditions for which a series of manurial experiments are being carried out (including the standard manurial experiments with paddy and sugarcane under I.C.A.R.) at different agricultural farms in the country. Manurial experiments so far carried out at different farms in India indicate that artificial fertilizer or organic manure alone does not give the best result but it is the combination of both organic manure and artificial fertilizer that gives the best result. In fact, the

present view is that artificials should come in only if there is a dearth of suitable organic matter or to supplement organic matter. The use of artificial fertilizer alone is however recommended if the amount of organic matter in the soil is high and it is suggested by many that organic manures help the utilization of artificial fertilisers by the crop.

Instead of going into a detailed discussion of manurial experiments carried out in different parts of India, a selected number of such experiments with artificial fertilizers alone or in combination with organic manures are noted in Table I and II, which will give some idea of artificial fertilizers found effective in different types of soil in India.

EFFECTS OF MANURES IN DIFFERENT TYPES OF SOILS.

TABLE I.—ARTIFICIAL FERTILIZER ALONE OR IN COMBINATION WITH OTHER ARTIFICIALS.

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
*1.	Samalkot (Madras)	Clayey and of average fertility	Paddy (Paddy—black-gram)	(1) Ammonium sulphate 112 lbs. plus superphosphate 224 lbs. (2) Superphosphate 224 lbs. (1) > (2)	1927-28—1930-31
*2.	Akyah (Burma)	Poor sandy soil	Paddy after paddy	Ammonium sulphate 30 lbs. N. plus superphosphate 30 lbs. P_2O_5 plus potash 20 lbs. K_2O > N.M. (No manure).	1925-26—1927-28
*3.	Hagari (Madras)	Black cotton soil	Sorghum — cotton (Direct effect on sorghum & residual effect on cotton)	Superphosphate 20 lbs. P_2O_5 plus ammonium sulphate 40 lbs. N > N.M.	1929-30 and 1930-31
*4.	Gaya	Soil calcareous clay, deficient in phosphates	Sugarcane	Superphosphate 30 lbs. P_2O_5 > N.M.	1928-29
*5.	Bankura (Bengal)	Soil of poor fertility.	Aus paddy	Nitrophoska or ammophos or nitro-chalk or leunaphos or nicifos (each 20 lbs. N) with no difference between treatments. Each > N.M.	1928-29—1930-31
*6.	Comilla (Bengal)	Low-lying, loamy, deficient in nitrogen	Aman paddy	Diammophos 200 lbs. (40 lbs. N. + 100 lbs. P_2O_5) > N.M.	1928-29—1930-31

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
*7.	Cuttack	Soil deficient in phosphates	Paddy (after paddy)	Ammonphos 25 lbs. N>N.M.	1926-27
*8.	Cuttack	"	"	Diammophos (12 lbs. N plus 30 lbs. P_2O_5)>N.M.	1928-29
9.	Karjat (Bombay)	Sandy loam	Paddy	Ammonium sulphate in doses of 40 lbs. N, 60 lbs. N, 80 lbs. N and 100 lbs. N. Each dose>N.M., but difference between different doses was not significant	1923 and 1926-28
*10.	Dacca (Bengal)	Soil of average fertility	Aman paddy	160 lbs. Ammonium sulphate (32 lbs. N.)>N.M.	1928-29- 1930-31
*11.	Kanki	Soil clayey deficient in phosphates and of low fertility.	Paddy (after paddy)	Ammonium sulphate (32 lbs. N)>N.M.	1926-27
*12.	Cuttack	Soil poor, deficient in phosphates	Sugarcane	Ammonium sulphate 50 lbs. N (at planting) plus the same 30 lbs. N (in May) plus the same 40 lbs. N in June>Ammonium sulphate 120 lbs. N applied after June.	1926-27
*13.	Gurdaspur (Punjab)	Soil—Heavy clayey loam	Sugarcane	Ammonium sulphate 45 lbs. N>N.M.	1926-27 -1929-30
*14.	Cawnpore (U.P.)	Medium loam	Wheat	Ammonium sulphate 24 lbs. N>N.M.	1926-27 and 1927-28
*15.	Totkon (Burma)	Sandy loam, deficient in P_2O_5	Ground nut	Nicifos (17/45) 100 lbs.>N.M.	1931
*16.	Hmawbi (Burma)	Swamp paddy land poor soil	Paddy (after paddy)	Basic slag 90 lbs. P_2O_5 >N.M. (with residual effects for 7 years).	1924-31

TABLE II.—ARTIFICIAL FERTILIZER IN COMBINATION WITH ORGANIC MANURE.

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
*1.	Cuttack	Soil low-lying deficient in phosphates	Wheat (fallow cane-wheat)	Ammonphos (20 lbs. N plus 20 lbs. P_2O_5)>oil cake (20 lbs. N).	1926-27
*2.	Kumta (Bombay)	Soil laterite	Paddy	F.Y.M. 5 carts plus ammonium sulphate 40 lbs. N>either treatment. (F.Y.M. 5 carts or ammonium sulphate 50 lbs. N alone.	1924-26
*3.	Palur (Madras)	Soil alluvial	Sugarcane	Groundnut cake plus ammonium sulphate totalling 200 lbs. N>the same 50 lbs. N.	1929-30—1930-31
*4.	Cuttack	—	Paddy (after paddy)	Green manure plus super 160 lbs. per acre>Green manure alone.	1926-27
*5.	Cuttack	—	Paddy (after paddy)	Bone-meal 18 lbs. P_2O_5 plus ammonium sulphate 16 lbs. N>N.M.	1930-31
6.	Shahjahanpur	Loam	Sugarcane (Co. 313)	(1) No manure, (2) 60 lbs. N (in equal quantities from castor cake, ammonium sulphate and cowdung), (3) 120 lbs. N (in equal quantities from castor cake, ammonium sulphate and cowdung), (4) 180 lbs. N (in equal quantities from castor cake, ammonium sulphate and cowdung). Doses compare as 180 lbs. N=120 lbs. N>60 lbs. N>N.M.	1934-35

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
7.	Jorhat	Reddish sandy loam, acid	Sugarcane (Co. 361)—plant cane	(A) Control. (B) Green manuring with cowpea. (C) → (B) + cowdung 50 lbs. N. (D) → (B) + oilcake 50 lbs. N. (E) → (B) + nicifos 50 lbs. N.	1936-37 (E) = (B), i.e., addition of nicifos does not increase the yield significantly. (C) > (A) = (B) (B) > (A) (E) > (A) (C) > (E)
8.	Jorhat	Reddish sandy loam, acid.	(a) Sugarcane (Poij. 2714)—plant cane	(a) 0 lb. P_2O_5 + 0 lb. K_2O (b) 60 lbs. P_2O_5 + 0 lb. K_2O (c) 90 lbs. P_2O_5 + 0 lb. K_2O (d) 0 lb. P_2O_5 + 100 lbs. K_2O (e) 60 lbs. P_2O_5 + 100 lbs. K_2O (f) 90 lbs. P_2O_5 + 100 lbs. K_2O (g) 0 lb. P_2O_5 + 150 lbs. K_2O (h) 60 lbs. P_2O_5 + 150 lbs. K_2O (i) 90 lbs. P_2O_5 + 150 lbs. K_2O All plot received a basal dressing of 300 mds. Cowdung + 1000 lbs. oilcake per acre. P_2O_5 was applied in the form of alphas, while K_2O was applied in the form of pot. sulphate. Only the effect of potash was significant, 100 lbs. K_2O and 150 lbs. K_2O , each yielding significantly greater than "no" K_2O .	1936-37
			(b) Do. ratoon canes	Residual effects of the above treatments. Residual effect of 90 lbs. P_2O_5 was significantly greater than "no" P_2O_5 . Residual effect of 150 lbs. K_2O was significantly greater than "no" K_2O .	1937-38
9.	Jorhat	Reddish sandy loam, acid.	Sugarcane (Co. 419)—plant cane	A. Control. B. Cowdung 175 mds. + mustard cake 1000 lbs. (=120 lbs. N in total). (C) Granular calcium cyanamide 600 lbs. (120 lbs. N) all plots including A received a common dressing of 125 mds. cowdung). B > C > A	1938-39
10.	Muzaffarnagar	—	Sugarcane (Co. 312)	(1) No manure. (2) F.Y.M. 120 lbs. N. (3) Neem cake 120 lbs. N. (4) Ammonium sulphate 120 lbs. N. (5) F.Y.M. 60 lbs. N plus ammonium sulphate 60 lbs. N. (6) Neem cake 60 lbs. N plus ammonium sulphate 60 lbs. N. (6) = (5) > (2) > (1) (3) = (4) > (1)	1935-36 The advisability of adding an organic manure to an inorganic whenever the latter has to be applied.
11.	Muzaffarnagar	—	Sugarcane (Co. 312)	To find the profitable dose of organic and inorganic manures and their mixture. Treatments:— Manures— (A) F.Y. manure. (B) Ammonium sulphate.	1937-38 Manures—Am. sulphate = F.Y. M. + Am. sulphate > F.Y.M. Doses—48 lbs., 64 lbs., 80 lbs., 96 lbs., N. doses per acre did not give significant results.

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
	Muzaffarnagar	—	Sugarcane (Co. 312)	(continued from the last page) (C) F.Y. manure + Ammonium sulphate in equal doses on N basis. Doses—(1) 48 lbs. N, (2) 64 lbs. N, (3) 80 lbs. N, (4) 96 lbs. N.	Profit—A mixture of F.Y.M. and ammonium sulphate on equal nitrogen basis at 96 lbs. N. per acre was the most profitable followed by ammonium sulphate at 48 lbs.
12.	Upper Shillong Farm	Higher lands coarse and reddish loam, low-lands clayey loam with a fair supply of all essential elements of plant food.	Potato	(1) Control. (2) Ammophos 225 lbs. (3) Nicifos 200 lbs. (4) Ammophos 225 lbs. plus sulphate of potash 200 lbs. (5) Nicifos 200 lbs. plus sulphate of potash 200 lbs. (All plots received a common dressing of 100 mds. cowdung per acre). (5) > (1); (4) > (1); (3) > (1); (1) = (2).	1935-36

N.B. Experiments marked with asterisk (*) have been noted from "Analysis of Manurial Experiments in India"—Vol. I, by M. Vaidyanathan (1934). The rest are recorded from the respective annual reports of schemes under I. C. A. R., excepting No. 12 of Table II, which is recorded from the Annual Reports of the Assam Agricultural Department for 1935-36.

The importance of artificial fertilizers that are in use in India and also the demand for them will bring home to the readers the importance and scope of extension and improvement of the hitherto neglected indigenous artificial fertilizer industry. The important crops requiring the use of artificial fertilizers in India are sugarcane, tea and paddy. Potatoes, vegetables, millets and tobacco also require fertilizers but in much smaller amount in comparison with that of any of the three noted before. Such important crops as wheat, cotton, jute, up to the present time, consume but negligible amount of artificial fertilizer.

IMPORTANT ARTIFICIAL FERTILIZERS

(i) *Ammonium sulphate*.—Considerable amounts of artificial fertilizers are imported every year, of which the most important is ammonium sulphate. According to Hendry (1940) before the outbreak of the present war, over 100,000 tons of ammonium sulphate were used in India per year, and more than three-fourths of this quantity were used by the ryot. Only a small fraction of the annual requirement of this fertilizer, about 18,000 tons, is produced every

year by the Sulphate of Ammonia Federation in Bengal and Bihar. In Mysore a plant has very recently been installed for production of synthetic ammonia. This marks an important development in the manufacture of artificial fertilizers in India. According to Ghosh (1940), "This would yield 6000 tons of ammonium sulphate which will fertilize the sugarcane fields of the State. The success of this enterprise will be watched with keen interest by Indian technologists and it is hoped that before long plants for the synthesis of ammonia and its conversion either to fertilizer or nitric acid will be set up in many parts of India where cheap electric power or cheap coal is available to meet the expanding requirement of these materials, under a system of well-planned economy in industry and agriculture". There is sufficient scope for increasing the output of ammonium sulphate from the present concerns and also for starting a few more manufacturing plants to meet its demand in India. Chatterjee (1938) has given a scheme including details for the manufacture of ammonium sulphate from synthetic ammonia, suitable for Indian conditions, which deserves attention.

According to Acharya (1938), India possesses in coal industry a potential source of over 200,000 tons

of ammonium sulphate per year, but unfortunately the coking industry is not at all well-organised in India, so he thinks that an annual production of 20,000 tons of by-product ammonium sulphate can be expected at present. The most effective way of meeting the demand of inorganic nitrogenous manures in India however would be to develop the manufacture of synthetic ammonia which will offer the best starting point for covering the whole field of nitrogenous fertilizers, *e.g.*, ammonium sulphate, nitrates, etc., and such compound fertilizers as calcium ammonium nitrate, ammonium sulpho-nitrate, bone-meal ammonium nitrate, etc.

(ii) *Nitrates*.—Sodium nitrate is another artificial fertilizer which is imported into India, but its import has considerably decreased during recent years. Deposits of Indian saltpetre (potassium nitrate) occur in parts of India. The crude Indian saltpetre and also the earths from which it is extracted are used locally as manure to some extent. But its major portion is refined into potassium nitrate for purpose of export. Many are not very enthusiastic about the advantages of Indian saltpetre manufacture from the point of view of its manurial use in India.

(iii) *Compound fertilizers*.—These are a series of compounds containing both nitrogen and phosphoric acid in different proportions and are cheap imported stuffs which are in use to some extent in India. Of these, we have different grades of ammophos containing 11%—16% nitrogen and 48%—20% phosphoric acid (P_2O_5) and different grades of nicifos containing 14%—18% nitrogen and 41%—18% phosphoric acid (P_2O_5). They are important in the sense that they contain two important fertilizing ingredients, *viz.*, nitrogen and phosphoric acid and have an advantage in weight in comparison with manures like superphosphate. There is some demand for these fertilizers and it will be well to investigate the possibility of their manufacture, or that of similar fertilizer from Indian resources at a cheap rate.

(iv) *Superphosphate*.—This is an important phosphatic fertilizer in use in India, whose import has for some years been nearly 7,000 tons per annum. Some 2,000 tons per annum are manufactured by Messrs. Parry & Co., of Madras and this is the only firm at present engaged in superphosphate manufacture in India, most of which is made from bones. There is obviously scope for extension of superphosphate manufacture in this country.

Opinion however is divided with regard to suitability of superphosphate and many would prefer to use ammophos, nicifos, etc., as they are cheaper than superphosphates and also have an advantage in weight.

(v) *Natural phosphates* are found in Madras and Bihar. These, as have been recorded by the Royal Commission on Agriculture (1928) in India, do not offer any important possibility.

A discussion on phosphatic fertilizers in India will not be complete without mentioning the case of bone-meal which, though not an artificial fertilizer, has attracted a good deal of attention in connection with phosphatic manuring of Indian soils.

From a rough estimate of the annual production of bones in India (made under the suggestion of I.C.A.R.) and from a rough average of the annual export of bones from India, it appears that only a small fraction of total bones is exported in various forms, while the major portion remains unutilized in India. Bones which are used in the form of bone-meals as manure in India form but a very small fraction of the total production of bones, and are obtained chiefly from bone mills. There are a number of bone mills, chiefly in Bombay, Madras, Bengal and United Provinces, manufacturing either bone-meal or crushed bones and bone-meal.

Bone-meal available from bone mills is rather costly to cultivators and increasing attention is therefore being paid (a) to produce cheap bone-meal, by developing production of bone-meal as a cottage industry, so that cultivators may use bone-meal with sufficient profit and also (b) to extend the use of bone-meal.

(vi) As most Indian soils are not deficient in potash, the demand for potassic fertilizers is small and consequently their imports are also small in comparison with those of other fertilizers. They are effective for certain special crops such as tobacco. India does not produce any potassic fertilizer except Indian saltpetre which, as has been discussed before, is not important from indigenous manurial point of view, although it contains two important fertilizing ingredients, *viz.*, potash and nitrogen. Prospects of use as fertilizers of potassium salts, which are present among beds of rock salt in the Salt Range of the Punjab, appear to be highly doubtful.

(vii) Fertilizers such as basic-slag, calcium cyanamide are used only to a very limited extent in

India. Large amounts of calcium cyanamide were imported in the past, but its consumption has recently been much reduced. No cyanamide is produced in this country and there appears to be little prospects of its manufacture in India.

CONCLUSION

Details which have so far been discussed refer mainly to normal condition just preceding the present war. In an emergency such as the present war, the increase in price of imported fertilizers is inevitable. As such the need of organised manufacture of artificial fertilizer in India is now felt more than at any time before.

It is quite in the fitness of things that the manufacture of artificial fertilizers is attracting increasing attention in India. It is now recognised in India, as Ghosh (1940) says, that the main objective of planning the national economy should be to attain as far as possible national self-sufficiency; and so far as food stuffs are concerned, this ideal can be attained with the arable land at our disposal and with the help of 50% of the population, if only modern methods of cultivation are introduced. Regular and systematic manuring of soils will, as a necessity, form an important part of these modern methods of cultivation, and more manures will have to be added

than at present. It appears from our present knowledge and experience of manuring of Indian soils that artificial fertilizers will supply the smaller fraction of this increased demand (while organic manures will supply the bigger fraction), but then India must have at her disposal a much greater amount of cheap artificial fertilizers than at present. There is thus enough scope for extension of the hitherto neglected artificial fertilizer industry in India. *

This industry has justly attracted attention of the National Planning Committee, whose findings and recommendations with regard to its developments with Indian resources will undoubtedly help in its advancement. Greater attention needs to be paid to this industry for its extension and improvement which will add to national wealth and prosperity.*

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PAVED ROADS REDUCE AUTOMOBILE COSTS

Like an elderly book-keeper's metatarsals, the automobile performs most effectively on hard, smooth pavement. At the Iowa State College, a study of rural mail-carrying vehicles shows that gasoline and oil costs go up substantially as the road changes from pavement to earth, and that maintenance costs are even more quickly affected by the nature of the road surface. For the cars used in the test and on a basis of 15,000 miles annually a car, the cost of operation is 36 per cent higher on earth roads than it is on paved roads.

Mysteries of the Microbe

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PASTEUR discovered the existence of billions upon billions of hidden lives so minute in size that some of them are discernible only by magnification from 600 to 1,300 times; others are still invisible even by the largest magnification that a microscope can produce. The existence of those, which are invisible even through the largest magnification of a microscope, can be demonstrated only by experimental transmission of the disease germ into animals and plants. In bacteriology these latter micro-organisms are called ultramicroscopic viruses. Hydrophobia, encephalitis lethargica (sleeping fever), small-pox and mosaic diseases of plants are caused by these viruses. A little brain substance or spinal cord of a dog dead of hydrophobia injected into the brain of a rabbit will produce the infection within 4 to 7 days. Similarly a little brain substance of a case of encephalitis put on the cornea of a rabbit after a tiny scratch on it by a needle will produce typical sleeping fever in the rabbit. Pus from the pustules of a case of small-pox can produce small-pox when inoculated into a cow or calf. The virus plant diseases are in most cases hereditary. In the plants grown from seeds of infected parent plants the manifestations of the disease can be seen as soon as the leaves come out.

Though Pasteur was the first to discover the existence of micro-organisms, it would not have been possible to obtain precise data of their existence, shape, size, method of multiplication etc., without the invention of the microscope in 1670, by the Dutch scientist, Leewenhoek. With the help of the microscope and test tubes, hundreds of varieties of these tiny beings have been discovered by producing infection caused by these organisms in laboratory animals and by biochemical methods. It would however be a mistake to hold the micro-organisms as capable only of doing damage to us. It is not generally known that most of them are friendly to human beings, helping them in various ways. Some seem to be neutral and only a limited number are harmful. The

viciousness of these limited numbers has earned a very bad name for all of them. For a long time scientists were engaged in identifying and isolating those micro-organisms which are inimical to human beings. Gradually however it has been revealed that the activities of the majority of these micro-organisms are actually beneficial to human and plant lives. This aspect of bacterial life is very little known except to scientists. Quietly, and beyond the range of human visibility, they perform their beneficial role in agriculture and industry, in the alimentary canals of man and animals, in the soil, in decaying matters, refuse heaps, and excreta. The rate of their multiplication is beyond imagination. We lately worked out the number of micro-organisms in the atmosphere of Calcutta. It came to 400 micro-organisms per litre of air. If nutrition is good, one micro-organism can multiply into 100 million in 24 hours.

The soil bacteria, of which there are a large variety, are responsible for increasing the fertility and for nitrification of the soil. The complex organic matter of leaves, dead trees, insects, animals, human and animal excreta are broken up by the soil bacteria into simpler substances which become readily assimilable to the plants for their healthy growth. Detailed study of these soil bacteria is increasing, and soil-bacteriology has now become a specialised and extremely important subject of scientific study. Organic manure is nothing but the product of bacterial decomposition and fermentation of soil, of animal excreta, of dead leaves and trees, and of insects. In the nodules of the roots and in the joints of leguminous plants there are innumerable micro-organisms which convert the atmospheric nitrogen into nitrates which are then readily utilised by the plants. During their metabolism, the soil bacteria produce a certain amount of heat which helps in maintaining the temperature of the soil required for the growth of vegetable and plant lives.

The fermentative activity of micro-organisms is extensively utilised in various branches of industry,

such as in the preparation of bread, (yeast fermentation) in manufacturing wine, alcohol and beer. Acetic and citric acids also are now being manufactured by fermentation process, utilising certain varieties of moulds and bacteria. Plants for the preparation of acetic and citric acids by microbial fermentation are now being erected to give products cheaper than by the method now in use. The vitamins B and D, which are essential for human life, are also being prepared from yeast.

There is a fungus secreting an enzyme called diastase—the active principle of saliva, which converts starch into sugar. This diastase is isolated and used in medicine for the treatment of patients who are unable to digest starchy foods, or where salivary digestion is defective. This particular variety of fungus, called *Aspergillus oryzae*, is grown in wheat bran medium where it grows profusely within 48 to 72 hours. The starch splitting enzyme is obtained from the fluid in sufficient quantity.

In the human intestines there are innumerable micro-organisms which help the digestive process. *Dahi*, a product of great nutritive value, is made by the action of lactic acid bacillus on milk. Lactic acid bacillus has got the power of destroying other harmful bacteria of the intestines, and supplies a certain amount of vitamins. Cheese, another valuable article of food, is a product of bacterial decomposition of casein, a milk product. Running cheese, or what in American term is called 'lavatory cheese' is nothing but cheese in an advanced stage of decomposition by these same bacteria. The more decomposed the cheese, the more easily digestible does it become.

In industrial areas the help of micro-organisms is availed of in the sewage disposal. The septic tank is a place where the sewage is allowed to be acted upon by micro-organisms and rendered inoffensive. The solid matters of sewage are almost totally liquefied, and provide a rich source of manure for cultivation.

I have given above only an outline of the friendly activities of the micro-organisms. The study of the life history of these micro-organisms is extremely interesting. There is a vast possibility of utilising the activities of friendly micro-organisms more and more in agriculture and industry. For instance, the utilisation of bacteria, which act upon cellulose, are being studied for the production of alcohol from water hyacinth. It appears that the utilisation of bacteria,

for transforming atmospheric nitrogen into nitrate, an essential chemical manure, is another subject worth investigating. In Europe it is not possible due to extremely cold weather, but in India the high temperature energizes their activity in the soil.

Some of the micro-organisms produce beautiful pigments—some golden in colour, others leaf green or citron colour, and some light scarlet. It is not impossible that some day these colouring pigments will be utilised as dyes. Some micro-organisms are phosphorescent, emitting distinct light with which the dial of a watch can be read easily. This phosphorescence is supposed to be due to the secretion by the micro-organisms of a substance called luciferin which when oxidised by atmospheric oxygen in presence of luciferase produces the light. This light can be experimentally produced if a fresh saltwater fish is kept for 48 hours in 5 per cent salt water with some glucose, peptone and glycerine added to it at 10°C. After 48 hours the fluid and the body of the fish will emit light.

Most of the micro-organisms prefer warmth for their activity and growth, but contrary to the general belief they can remain alive longer in cold. In cold drinks and ice-cream, the micro-organisms remain alive and as soon as they find suitable nutrition and warmth they begin to flourish and multiply as usual, often in the intestines of the person drinking cold drinks or eating ice-cream. We therefore seem to be constantly living in a danger zone. Fortunately there is the defensive mechanism of the human body working against all possible dangers of infection. The gastric juice containing hydrochloric acid can kill most of the micro-organisms, if the stomach is functioning normally. Experimental results show that cholera bacilli are killed by 1 per cent hydrochloric acid in less than 1 hour. Typhoid bacilli are killed in less than 3 hours. Infection takes place mostly if contaminated water is taken on an empty stomach when there is no hydrochloric acid available.

During the last war the army paid a heavy toll to gas gangrene. There are several varieties of these gas gangrene bacilli. At the Pasteur Institute of Paris, I had the opportunity of working on gas gangrene bacillus with one of the greatest authorities on gas gangrene, Prof. Weinberg, who was specially deputed by the French Government to investigate the cause of gas gangrene. One of these gas gangrene bacilli, called *B. Histolyticus* can entirely dissolve the skin, muscles, blood vessels, etc., of a living being

within 24 hours. It is a horrible sight to see an animal or a human being having *B. Histolyticus* infection.

Constant research work however has been in progress all over the world to find antidotes against each of these microscopic agents of destruction of human lives. Two different kinds of antidotes have been invented and used successfully against infection by these microbes, *viz.*, (i) specific biological products such as anti-sera and vaccines, and (ii) specific chemotherapeutic products, vegetable alkaloids and glucosides, such as Neosalvarsan, Hexamine, Emetine, Quinine, Mercurial derivatives, Sulphanilamide, etc. Thanks to the discovery of specific anti-sera, tetanus, diphtheria and gas gangrene infection can be controlled and cured if the serum can be administered in time. Towards the end of the last war when due to the rigorous blockade, anti-sera could not be imported into India, many patients died of tetanus, diphtheria, cellulitis and erysipelas. It is a matter of great satisfaction that India can now produce almost the entire need of anti-sera against these dangerous infections.

In recent years research has shown that micro-organisms are attacked by still tinier micro-organisms called bacteriophage, the existence of which was discovered by Wort and D'Herelle, rather accidentally. These bacteriophages can be isolated and when the specific bacteriophage is added to a culture of *B. Dysentery*, *B. Typhoid* or *B. Cholera*, they can liquefy the bacterial body and make them inert. These bacteriophages are now used successfully in the treatment of dysentery infection of the bacillary type, and also with fair success in typhoid and cholera.

Of the harmful micro-organisms against which unfortunately no specific remedies have yet been found, *B. Tuberculosis* is the most important. The late Professors Calmette and Koch devoted their lives to find a remedy against tubercular infection. Failing to find a specific remedy, either biological or chemotherapeutic, they turned their investigations to the prevention of tuberculosis. Prof. Calmette was able to prepare a prophylactic vaccine called *B. C. G.* vaccine which when given orally within a few weeks after the birth of a child tended to prevent infection in later life. Later more work showed that such vaccination could in later years avert mild infection by tubercular bacilli but it did not give absolute protection against massive tubercular infection. The present-day method of treatment of tuberculosis is based on rest and nutrition. Long confined rest of the affected lung, and good nutritious diet are the methods now adopted.

Though no specific remedy is available for the treatment of typhoid, cholera, plague and small-pox, these can be successfully prevented by prophylactic inoculation of the respective vaccines. The micro-organisms responsible for causing epidemic diseases, such as cholera, small-pox, plague and typhoid, have been long discovered, but the epidemiology has not yet been precisely understood. Why these diseases break out in epidemic form at certain seasons and at certain localities has not yet been solved definitely. Let us hope that intensive and patient research will find a solution of this problem in the near future.*

* Adapted from a lecture delivered by the author at a meeting of the Rotary Club of Calcutta.

An Account of Edible Mushrooms of India

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INTRODUCTION

[IN India there is no cultivation of mushrooms. This is due to the superstitious nature of our countrymen. The idea of raising truffles and edible mushrooms on beds of horse-dung or any other dung is very repulsive to the feelings of the people of our country. The mushrooms are generally picked up from the field, and sold or consumed as such.]

The Hindus and the Mahomedans are averse to eating mushrooms. They look down upon these as an inferior type of article of diet. To the non-Aryans mushrooms form an important constituent of their food. [In the hills and jungles the Santal and Paharia women can be seen picking baskets of those mushrooms which they know to be edible. These grow so abundantly in forests and on uncultivated tracts that the primitive tribes have never found it necessary to cultivate them. These can be bought in bazars or *hats* wherever forest and jungle tribes abound.]

[The Santals have an idea that thunder causes the fungi to sprout. M. A. Henry, in an article in the *Scientific American* (Vol. 124. No. 6, 1921), has shown that continual discharges of artificial 'lightning' produced by a large static machine caused a very marked effect on speed of growth and size of the cultivated mushrooms. This experiment thus confirms the Santals' popular belief.] The edible mushrooms are much used in curry, and some of these constitute first class delicacies. The Santals somehow have no difficulty in distinguishing the edible from the poisonous varieties. But on the other hand, cattle are known to die after taking poisonous mushrooms.

[Here follows a list of the varieties of mushrooms eaten by the Santals.] The probable botanical names are given side by side. In the *Memoirs* of the Royal Asiatic Society of Bengal (Vol. 10, part 2, 1940) Rev. P. O. Boding has given a long list of Santali names of edible mushrooms.

Bin ot, snake mushroom, so named from shape. (Probably *Leptota mastoides*).

Bunum ot, lit. white-ant hill mushroom (*Entoloma macrocarpum*) so called because it is found on white-ant hills. Considered delicious.

Busup ot, lit. straw mushroom (*Volvaria terastius*); found growing on old, often decayed straw. Considered good.

Dak Mandi ot, lit. rice-gruel mushroom. Considered savoury. (*Entoloma microcarpum*).

Gopha ot, a very large kind of edible mushroom (*Collybia albuminosa*).

Gundri gopha ot, a mushroom said to be intoxicating but sometime eaten. (A variety of *Collybia albuminosa*).

Hasa ot, lit. earth mushroom. Eaten boiled. Found in Asar and Bhadra (*Agaricus campestris*).

Hati ot, lit. elephant mushroom (*Boletus sp.*), large, bad-smelling. Rare, said to be eaten only by old people.

Hurul ot, lit. tree-stump mushroom (*Lentinus subnudus*). Eaten boiled. There are two species: *Sisir hurut ot*, lit. dew tree stump mushroom, also called simply *Sisir ot* found after the rains have ceased: and *pond ot*, lit. white mushroom (*Lentinus subnudus*) found during the rains. Both eaten boiled.

Kat ot, lit. wood mushroom, found growing on tree-stumps (*Pleurotus ostreatus*).

Karna ot, lit. bitter mushroom (Puff-ball); named due to the taste. Found in Bhadra.

Karna patka ot, (variety of Puff-ball).

Kod ot, so called on account of its black colour, resembling the fruit of the *Kod*, *Eugenia jambolana*, Lamk. (*Coprinus comatus*).

Mat ot, lit. bamboo mushroom (*Collybia* sp.) because it is found growing on stumps of the hill bamboo. Considered very savoury.

Motam ot, Besides being eaten as an ordinary food, it is given to persons suffering from small-pox, because it is believed to bring out the eruption. (variety of *Collybia albuminosa*).

Muci ot, lit. the Muchi's mushroom (a variety of *Entoloma microcarpum*).

Murum ot, possibly so named owing to its colour, as murum means reddish (*Clavaria* sp.).

Or tot ot, lit. pulled out mushroom, so called, because the whole of the mushroom (rooting *Collybia albuminosa*) is pulled out of the ground.

Otec ot, lit. burst open mushroom (variety of *Collybia albuminosa*). It is white in colour and commonly found in August.

Patka ot, (Puff-ball).

Bond kat ot, lit. white wood mushroom, a variety of *Kal ot* (*Pleurotus* sp.).

Pond tomar ot, a whitish variety of the tomat ot (a variety of *Geaster*).

Putka, the puff ball, a fungus of the *Lycoperdaceae* family. The Santals recognise the following edible varieties. *Erok putka* lit. sow. puff ball, so called because it appears at sowing time, earlier than the other *putka* it is also called *hor putka*, *Lycoperdon giganteum*, *Calvatia* sp., lit. man puff ball and *Ruhni putka*, because it may be gathered during ruhni; *rote putka*, lit. frog puff-ball, a small kind; *seta putka*, lit. dog puff ball (Truffle) which has a rough surface. The Santals very much relish eating these naturally in their early stage of growth.

Rote ot, lit. frog mushroom (small puff ball).

Seta ot, lit. dog mushroom; the same as seta putka (Truffle).

Sim ot, lit. fowl mushroom, reddish in colour (*Cantharellus cibarius*).

Sisir ot, lit. dew mushroom, found growing on stumps of the Sal tree (*Lentinus subnudus*).

Tormar ot, eaten, but not very common (*Geaster* sp.).

Tumba ot, lit. gourd-shell mushroom, of a large round shape (*Bovista gigantea*).

As regards mushrooms, a Santal writes, 'Mushrooms sprout from decayed leaves or straw, and from white-ant hill and cowdung. We boil them in oil adding spices, add a little rase, sauce, soup and eat them. Sometimes we also make a hash of them, cooking them with rice. A few kinds, we also eat raw'.

Baden Powell and others gathered a great deal of information on edible mushrooms in India. Their observations were published in *Indian Agriculturist*, *Journals of the Agri-Horticultural Society of India*, and other local journals (1863-1911). Baden Powell

noted three kinds of edible mushrooms in the Punjab (1863): (i) The mushroom (*Agaricus campestris*), (ii) The morel (*Morchella esculenta*), and (iii) Truffle (*Tuber*).]

Later in 1886, some fine specimens of mushrooms were grown by Mr. H. W. Newton and exhibited at the annual show of Agri-Horticultural Society of India. It was entirely a private attempt and created a good deal of interest. In 1908 there was a thorough and searching enquiry instituted by Sir David Prain about the edible mushrooms from all parts of India. It attracted his attention as it was used as famine-food in different parts of our country, specially among the poor during the famine of 1896-97.

FUNGI AS FOOD.

Fungi have probably been eaten from prehistoric times. Pliny states that fungi are the 'only food which dainty voluptuaries themselves prepare with their own hands and thus, as it were, by anticipation feed on them, using amber knives and silver service'.

The delicate appearance of some of the edible fungi has from time immemorial tempted man to use them as articles of food. It is used extensively in the dry regions of Bengal, and also in the valley of Kashmir. There is a large demand for mushroom among the Burmese people. The varieties known in Bengal are the following (vide Protap Chandra Ghosa in *Indian Agriculturist*, April 3, 1886):

(i) *Phudki-Chhatu* (the small and the large), (ii) *Puwal-Chhatu*, (iii) *Kadan-Chhatu*, (iv) *Durga-Chhatu*, (v) *Urji-Chhatu*, (iv) *Kud-kudi Chhatu*, (vii) *Kat-Chhatu*, (viii) *Govar-Chhatu*, (ix) *Indu-Chhatu*, (x) *Pachan-Chhatu*, (xi) *Kondka-Chhatu*, and (xii) *Gundura-Chhatu*.

Of these nos. (vii), (viii), (xi), are considered unfit for food. None of the above named varieties of truffles and mushrooms are cultivated in Bengal. Some attempt to raise a few poor specimens of *Puwal-Chhatu* by allowing waste straw to rot in a heap. They depend on chance for the germination of these mushrooms.

The nutritive quality of fungi has been questioned in recent years. Numerous analyses have been made of edible fungi. The composition varies for different species, and there is considerable variation in the analyses given for the same fungus, probably owing to the composition varying with age and

differing in different parts ; a young specimen is more nutritious than an old one, the cap more nutritious than the stem.

[Chemical analysis of some local mushrooms were carried out by Dr C. B. Roy, late Demonstrator of Chemical physiology at the Calcutta Medical College, to whom our sincere thanks are due. From the following table of analysis, it will appear that some of them are even superior to the English mushroom :

LOCAL EDIBLE VARIETIES.

	Protein	Carbo- hydrates	Fats (ether extrac- tives)	Ash	Moisture
	Per cent.	Per cent.	Per cent.		
<i>Volvaria</i> <i>terastius</i>	2.28	trace	0.18	...	Analysed in dried condition Analysed in dried condition 95.2% 93.85%
<i>Collybia</i> <i>albuminosa</i>	12.8	14.8	trace	...	
<i>Agaricus</i> <i>campestris</i>	2.736	1.6	0.37	0.15	
Puff balls	2.2	1.35	0.56	0.916	

ENGLISH EDIBLE MUSHROOM.

(*Agaricus campestris*)

[According to G. Massee.]

<i>Agaricus</i> <i>campestris</i>	0.18	0.46	0.03
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AMERICAN EDIBLE MUSHROOM.

[U. S. Dept. Agri. Bull.]

No. 79.

<i>Agaricus</i> <i>campestris</i>	2.25	4.95	0.20		91.30%
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From the table it is evident that our local *Agaricus campestris* (Fig. 1) is much richer in protein than the English *Agaricus*, it is also richer in fat than both the English and the American members of the same species. *Collybia albuminosa*, which is called in local vernacular "*Durga Chattu*", is much richer than others. In the amount of water they contain, fungi resemble green vegetables. In certain regions either where the country is infertile or where

primitive tribes abound, fungi form the main food, as in Pucgia, where *Cyttaria* is staple food during many months of the year. [The amount of nutrient in mushrooms is very small] It is mainly as condiments that they are valuable. Meat, bread,



FIG. 1. Edible mushroom
Local *Agaricus campestris*

beans, are very nourishing, but who wants to eat these at all times? [The chief value of mushrooms is that they act as appetisers, giving variety and flavour to other more nutritious food. They are also very rich in vitamins.

POISONOUS MUSHROOMS

[At most there are not more than a dozen poisonous kinds that must be avoided at all cost whereas the edible species number more than a hundred. Prof. Peck lists close to 200 species that have an unblemished reputation for edibility. In order to avoid poisoning by mushroom the best way is to know the killers first—to recognise them by sight and then to be able to pick out the edible kinds. Many writers give general rules as to the kinds of mushrooms to avoid, such as those with a volva or a sack, those

with pink spores, those growing in woods etc. These rules are of some value. But the one golden rule, not to eat a fungus until its identity is certain, will avoid accidents. The fungus selected may be sent to a specialist for determination.

Among the poisonous mushrooms the deadly *Amanitas* and false morels (*Gyromitra*) take the lead. The worst poisonous species are in the genus *Amanita* (*Amanita phalloides* and *Amanita muscaria*) (Fig. 2).

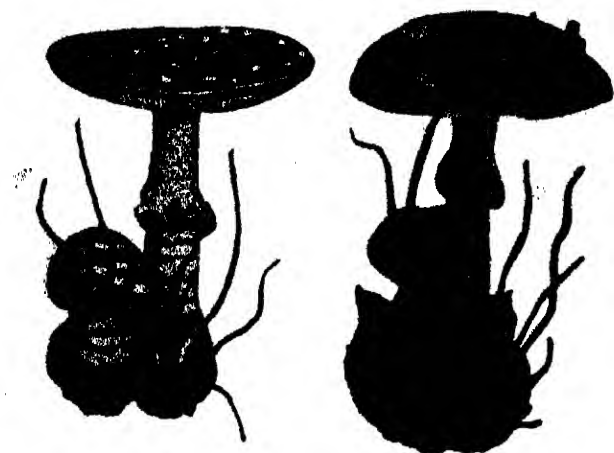


FIG. 2. Two poisonous mushrooms
(a) *Amanita muscaria*, (b) *Amanita phalloides*

So it is always safer to go by some general rules for the beginners in order to avoid the genus *Amanita*, and to avoid all that are no longer fresh and firm or which have small burrows due to grubs. Avoid all that have a powerful peppery or nauseous taste. Avoid those with a milky juice. To know the easily recognised *Amanita* group settles the question of any great danger to life in eating mushrooms.

Let us dwell a little on the characters by which they are recognised. First of all, when young "in the button", they are egg-shaped and completely enclosed in a veil or sac (called volva) which ruptures, as the cap pushes upwards, and remains attached at or near the bulbous base as a cup with fragments or warts (appropriately known as the "death cup"). In order to recognise this most important marking it may be necessary to dig up the *Amanita* with care as the cup may be concealed below the ground. If you cut off the fungus above the cup, you might easily be led to exclaim "No cup, therefore safe to eat". Secondly, the *Amanitas* have a ring on the stem above the cup, just below the cap. The *Amanitas* grow on the ground, never on trees. Lastly, many of the poisonous *Amanitas* are further distinguished from our edible mushrooms by having white gills,

and if the caps are laid on a piece of paper when mature, they all shed white spores whereas *Psalliota* (*Agaricus*) *campestris* sheds dark purplish spores. In "Prabashi" of Aswin, 1337 (Sept. 1930) (a Bengali monthly from Calcutta) one of us (S. R. Bose) described in detail, the points of distinction between the common edible mushrooms and the deadly poisonous ones in the field, with coloured plates of the edible *Agaricus campestris* and the poisonous *Amanita muscaria* as well as of the *Amanita phalloides*.

[*Russula emetica* is poisonous (muscarin is present in this species). In *Gyromitra esculenta* the cap is more or less convoluted, brain-like in appearance. Its poisonous principle, helvellic acid, has been isolated. In the purple-brown spored group *Hypholoma fusciculare* and several species of *Stropharia* are reckoned as undesirable stuff. *Panaeolus* species with their black spores, though not extremely poisonous, can be the cause of considerable anxiety.]

TYPES OF MUSHROOM-POISONING

Ford recognizes five types of mushroom-poisoning.

(1) Gastro-intestinal type, characterised by early symptoms of nausea, vomiting and diarrhoea. Rarely fatal. Causative mushroom: *Russula emetica*.

(2) Choleriform type, gastro-intestinal symptoms developing in from 10 to 15 hours, followed by rapid loss of strength and weight. The death rate is high. Causative mushroom: *Amanita phalloides* (and closely related species). It is reported that an anti-toxic serum against the poisons of *Amanita phalloides* has been prepared. In the Bayer's laboratory at Munich they isolated in October 1938 the poisonous principle of *A. phalloides*, which they have named "Phalloidin". It generally causes rapid fall of the blood sugar which can be restored by administration of a suitable amount of glucose.

(3) Nerve-affecting type, early gastro-intestinal symptoms terminating in violent convulsions, delirium, coma and often in death. The active poisonous principle is muscarin, for which the perfect antidote is atropin. Causative mushroom: *Amanita muscaria*.

(4) Blood-dissolving type, abdominal distress, followed by jaundice. Death may occur. Blood transfusion is suggested by Ford as the logical treatment. Causative mushroom: *Gyromitra esculenta*.

(5) Cerebral type, transient symptoms appear shortly after the meal. They are exhilaration, staggering gait, and queer disturbances of vision. Causative mushrooms: various species of *Panaeolus*.]

COMMON EDIBLE MUSHROOMS

Among the edible mushrooms the names of Puff-balls, the Morel, the Golden chanterelle, the Cepe, and the cultivated meadow mushroom are well known. In the *Agricultural Journal of India* vol. XVI, 1921, a list of common edible mushrooms has been given by one of us (S. R. Bose) with chemical analyses of some.] Among the common edible mushrooms of Bengal the following may be mentioned:—*Volvaria terastius*, *Volvaria diplasia*, *Collybia albuminosa*, *Lepiota mastoides*, *Entoloma microcarpum*, *Agaricus campestris* and some small puff-balls from Bankura. *Collybia albuminosa* is called in local vernacular 'Durga-Chhatu' (as it appears in September to October, usually during the time of Durga Puja ceremony). *Urji-Chhatu* is considered as the most delicate in flavour in Bengal. They are found generally under the ant-hills. In Bankura and Birbhum districts these are collected by the low-caste dwellers of the forest, and sold to the villagers in exchange of rice, tobacco, or salt. A kind of *polao* is made with these mushrooms and it is considered not at all inferior to *polao* made with meat.]

[When in prime condition, the interior of the large puff-balls is solid and pure white. Indeed the mushroom simulates a good sized ball of cottage cheese covered by a skin that later bursts and spores are set free. When the spore-ripening process starts, yellowish brown droplets appear as soon as a knife is passed through the body of the mushroom. At this stage the substance is no longer fit for food, a distinct bitterness having developed. There are 2 species worth mentioning viz., *Lycoperdon saccatum*, *L. giganteum*. The smaller puff-balls, *Lycoperdon gemmatum* and *L. piriforme* are also edible, but in these the spores ripen very soon and hence it is rather uncommon to find them in the proper stage for being eaten.]

(With the exception of *Clavaria dichotoma*, a slender, regularly branched, flaccid, pinkish-white species, all *Clavarias* are safe to eat.) In *C. fusiformis* the plant consists of a tuft of clubs. These are not of the very best taste, but in the absence of better kinds or as bulk-makers with others, they are not to be ignored.

[Perhaps the easiest of all edible mushrooms to recognize is the Morel, *Morchella esculenta*. It is a great favourite of the Europeans. The only poisonous species that may be collected in its place is the False Morel, *Gyromitra esculenta*. The distinction lies in the character of the cap. The true Morel has a pitted head, whereas the false one has the cap convoluted like a brain. *Cantharellus cibarius*, the Golden Chanterelle, is highly prized by mushroom-lovers. Bearing not less than two hundred pet names in the countries of Europe it has been a favourite for more than four centuries. It is a small mushroom with a trumpet-like shape, but with a solid, unperforated body, with blunt-edged and much inter-grown gills, and with a colour like that of the yolk of an egg fried hard. Both *Morchella esculenta* and *Cantharellus cibarius* (called in vernacular "Pastu") are sold in the markets of Peshwar and Lahore in the dried state at a high price. *Cantharellus aurantiacus* is an unwholesome species, though edible. In the Kashmere valley the *guchha* is much used. This mushroom has the closest resemblance to the truffles (=sp. of *Tuber*) of Europe. It is sold in Kashmir shops in a dry state, and the older the article the greater is its value. The Kashmiris seem to be aware of the fact that the objectionable properties of fungi are minimized by keeping.

Hydnum coralloides, growing on decomposed stumps of *Deodar* trees, has been reported to be edible from Dehra Dun area but Krieger remarks that it is not so tasteful. The trumpet-shaped *Craterellus*, *C. cornucopioides* is another fungus that can be gathered and eaten without trepidation.

Among the tough fleshy *Polypores* (bracket fungi) only young specimens of three or four species are sufficiently tender to serve as food. Perhaps the best known is the Beefsteak, *Fistulina hepatica*; it was reported from Darjeeling by Hooker. A sure sign that one has got the species is the strange movability of the skin of the upper surface. Due to the underlying gelatinous layer this skin can be pushed exactly like the skin on the back of an open hand. Only the young knob-like beginnings of caps of the chicken mushroom, *Polyporus sulphureus*, should be eaten, it grows on trunks of *Eucalyptus* trees in Shillong (Assam).]

Coming to the white-spored gill mushrooms the danger zone is entered, for the deadly *Amanitas* belong to this group. [The Umbrella mushroom, *Lepiota procera*, can be safely eaten. It is a tall mushroom, and though in common with the *Amanitas* it has white

spores, there are clear distinguishing features such as—the umbonate cap, the scales on the cap, the thick ring (which in older plants can be moved up and down like an encircling bracket); the base of the stem, though enlarged, bears no trace of scales, or bag-like volva. To those using a microscope the spores offer an additional means of identification. spores of *Lepiota procera*: Ovate, $18\ \mu$ in length; spores of *Amanita muscaria*: Round, $9\ \mu$ in diameter. *Collybia velutipes* is also used by some enthusiasts. Its taste is rather insipid.]

The purple-brown spored series is quite safe for the timid mycophagists. This is true, above all, of the genus *Psalliota* which contains the meadow mushroom *Psalliota (Agaricus) campestris*. A group of fairy rings of *Agaricus campestris* was noticed in the lawn of the compound of Prof. S. N. Bose, the Dean of the Faculty of Science of the Dacca University on 26th May, 1940; the specimen on examination was found to be mostly two-spored and some had three-spored basidia in the hymenium. On the southern side of the Calcutta Fort in the maidan in June, 1940, two fairy rings of *Agaricus campestris*, each 2 ft. 2 in. in diameter, were found; these specimens on examination showed two to three spores on their basidia. Adjacent to this spot a wider ring (7 ft. 3 in. in diameter) of edible *Lycoperdon* (Puff ball) could be seen. These fairy rings of mushrooms are usually known to expand in diameter every year.

CULTIVATION OF MUSHROOMS

There is no regular cultivation of mushrooms in India for the market. It is rumoured that serious attempts are being made in Sind to cultivate mushrooms on a commercial scale. There is a large demand for mushrooms among the Burmese people. Recently in 1936, experiments on the cultivation of *Volvaria diplasia* (the edible mushroom) have been successfully carried out in the Agricultural College, Mandalay (Burma) from which the local people obtain supply of pure spawn to grow mushroom in their own fields. Spawns of *Volvaria diplasia* are sold in flasks by the Agricultural Department. The spawn is prepared in the laboratory. Spores can be germinated but it is found more convenient to take a piece of the tissue from the inside of a button which has been sterilised outside. The tissue is cultured first on Quaker oats, then on Brown's medium and ultimately transferred to sterilised straw or dung (of cow or horse). It becomes ready in about a month's time.

In Burma, production is, of course, the best during the rains but it is possible to cultivate it from March to the end of October. Dr L. N. Seth of Mandalay is soon bringing out a paper on "Cultivation of Straw Mushroom (*Volvaria diplasia*) in Burma" in the *Indian Farming* in course of the current year.

There are many wild species of edible mushrooms in our country but those commonly used as food and grown privately are varieties of *Psalliota (Agaricus) campestris* and *P. arvensis*. Several other kinds of fleshy mushrooms are sold in Asia and Europe. The Cepes and truffles of Europe, the Kames of North Africa, the Shii-take and Matsu-take of Japan are familiar to the mycophagist. In Europe and America there is a great demand for cultivated mushrooms. In those countries the cultivation of mushrooms in specially constructed buildings, in old ice houses, in abandoned mines, tunnels, quarries, and in other places, has in the past few years steadily increased.

Mushroom can be grown all the year round, if the temperature suitable for their proper development can be maintained. In deep caves and mines this is possible without artificial heat in winter or refrigeration in summer; above ground it is rather expensive to secure either of the conditions stated above. It is for this reason that the small grower begins operations in early winter.

MUSHROOM BED

In cultivating mushrooms a suitable place for growing them is the first consideration. A cool closed shade or outhouse, or a vacant room in a disused building, with only sufficient openings to admit of a little air and subdued light will make the most suitable plot for cultivation of mushrooms. The next step is the preparation of the bed (Fig. 3). This is done carefully in the following manner:—Fresh horse droppings, if possible of well-fed and sturdy animals, freed from grass and straw, is daily collected, and kept under cover of a shed or outhouse, spread thinly over the floor to prevent premature fermentation. When sufficient quantity has been collected to form a bed, 3 ft. broad, 3 ft. deep and any length from 6 ft. upwards, formation may then be commenced. To secure perfect drainage, the foundation of the bed should consist of a layer of broken bricks 3 inches deep. A layer of droppings, 10 inches deep, tramped firmly down, should then follow, next a layer of earth 2 inches deep, composed of two parts of good friable garden soil, one part of decomposed cowdung, and

one part of decomposed sheep or goat dung ; then a second layer of droppings of the same depth as the first, trampled firmly down as before and covered with the mixture of soil as before ; and finally a third 10-inch layer of droppings, also trampled firmly down with a covering of earth, but the latter need only be an inch deep, and should not be added until after the first most violent fermentative action has passed off.

Spawn is contained in hard solid bricks, formed of dried cow and horse-dung. It should be broken into pieces two inches square, and inserted in the fermenting material of the bed an inch deep, and at 6 inches apart. After insertion of the spawn, the bed should be finished off with its final coating of earth, and the latter kept dry for a time. If the spawn is good, it will grow actively in 8 or 10 days, and in the course of 15 or 20 days it will take possession of the



FIG. 3. Mushroom-beds ready for spawning

A second plan of forming beds is to mix the horse-droppings with decomposed cowdung, good garden soil, and goat or sheep dung. The last three ingredients should be in equal proportions and when mixed together, should be equal to one-fifth of the bulk of the droppings. The whole should then be well mixed and laid over the foundation of broken bricks to a depth of 3 feet, pressing firmly down, and finishing off with an inch of good soil as a covering, after active fermentation has ceased. Should the droppings become too dry after collection, they may be moistened with water before being formed into a bed, to the same degree as when freshly deposited. After a bed has been formed, it should be allowed to ferment for 12 or 15 days, and when the temperature has cooled down to 90° or 85°F., it is ready to receive spawn and its upper covering of the earth. The temperature may be taken by making a hole perpendicularly through the centre of the bed, large enough to insert a thermometer.

whole bed. It is however advisable to examine the bed every few days and replace such spawn as does not thrive, which can be seen by the absence of white filaments in the surrounding material. If culture is carried on in a closed room, nothing further requires to be done but to wait for the appearance of the crop, which may occur at any time from six weeks to two and a half months from the date of spawning. If, however, the bed is placed in the open, or in a structure not free from draughts of cold air, it must be covered with straw loosely thrown over to keep a uniform temperature all round it. After the mushrooms begin to appear or even before they begin to appear if the soil on the surface of the bed become very dry, lukewarm water should be given from a watering pot with a fine rose two or three times a week.

When beds first begin bearing, the crop is generally very prolific, but in course of time the quantity produced will naturally fall off. When this is seen

to be the case, the bed can be stimulated into renewed vigour by applying liquid manure twice a week made up as follows: Take fresh cow-dung 10 seers, goat or sheep dung 3 sheers, fowl manure $\frac{1}{2}$ a seer, salt-petre 4 ounces, water 10 gallons, and stir the whole together, allow the solids to settle, and water with the supernatant liquid.

In order to maintain a succession of mushrooms, it is advisable to possess several beds made up at intervals of about six weeks. By having beds in bearing, and beds in course of formation in the same room, the heat given off in fermentation will be of great assistance in maintaining the temperature at an even genial figure.

RECENT METHOD OF PURE CULTURE OF SPAWN

While on the subject of the culture of the mushroom-spawn it may be pointed out that Dr Cayley (*Annals of Applied Biology*, Vol. XXIV, No. 2, pp. 311-322, May 1937) has remarked that the popular idea that the horse is necessary for the growth of the mushroom is a fallacy and that the cultivated varieties would develop normally without manure or urea in artificial media. She has tried artificial composts for growing spawns of all forms of mushrooms, both wild and cultivated. As a result of several trials she recommends the following standard unfermented compost: 2 g. dry chopped straw; 2 g. dry chopped hay per tube; 2 g. crushed oats and $\frac{1}{2}$ oz. coarse sand (previously washed and dried). The straw and hay are thoroughly mixed and moistened with 10 c.c. rain water; the crushed oats and dry sand are then mixed in the compost placed in the tube and pressed down lightly, and a layer of dry sand placed on the surface of the compost. The whole is then again moistened with 10 c.c. of nutrient solution and sterilized on three successive days (Fig. 4). The compost will then be moist but not too wet, and the superfluous liquid which drains to the bottom of the tube should not be more than $\frac{1}{2}$ to 1 c.c. deep. It is essential that the compost should not be saturated as the mycelium requires aeration. The crushed oats serve as additional nutriment.

In a subsequent paper Dr D. M. Cayley (*Annals of Applied Biology*, Vol. XXV, No. 2, Pp. 322-340, May, 1938) has supplied the details as to ingredients and methods of treating artificial composts. The results of her tests show that previous high temperature fermentation of the compost is not essential for the growth of the mushroom itself, although in the

case of the saprophytic cultivated varieties, previous fermentation may make the necessary nutritive ingredients more easily available to the fungus. Her experiments definitely show that the two wild grass land species *Psalliota campestris* and *P. arvensis* will not grow on either fermented manure or any fermented artificial compost so far tested, but spawn grows quite freely on unfermented freshly sterilised straw and hay, and that mainly proteins, hemicellulose and cellulose are required by the fungus during the earlier stages of growth but

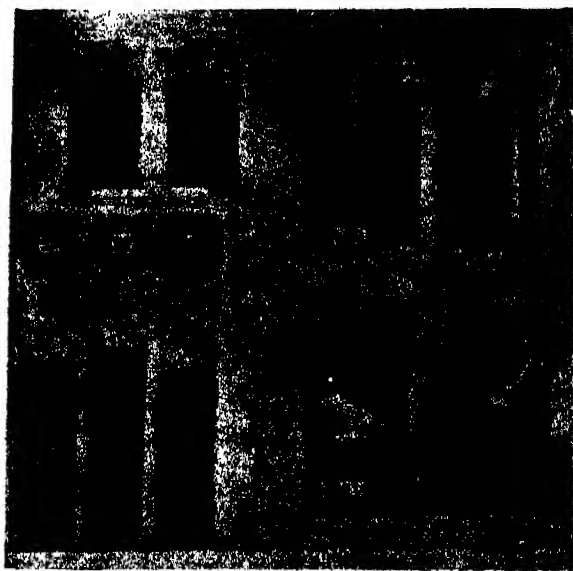


FIG. 4. Pure culture of mushroom—spawn in artificial compost. Edible mushrooms have appeared within 4 of the culture-jars.

that lignin or lignin-derivatives may possibly be necessary for fructification. At p. 324 she has remarked that 'in view of the fact that, up to the present time, stable manure has been almost exclusively used for mushroom beds by the trade and private growers, the ingredients for the artificial composts described in this paper were based on the food of horses, namely, hay, grass and crushed oats, with the addition of straw. These ingredients are easily obtainable in this country, and at a low cost'. In a paper in 1938 (*Journal of the Royal Horticultural Society*, Vol. IXIII, Part 7, pp. 325-333, 1938) she remarks that an ideal manure for mushrooms is still wanting.

RECENT LITERATURE ON EDIBLE MUSHROOMS

The Ministry of Agriculture and Fisheries, England, issued a handbook on mushroom-growing

in 1931 (*Bulletin* no. 34) where the recent methods of cultivation of edible mushrooms of England are fully set out; in 1934 they issued a handbook on edible and poisonous fungi with coloured plates as *Bulletin* no. 23. Ramsbottom (1929—*Fungi*. Benn's six penny library) has also briefly dealt with the common method of mushroom cultivation adopted in England. Recently in 1934, Dr J. B. Cleland brought out two volumes on *Toadstools and Mushrooms of South Australia*, where he has dealt with fungi as food and with preparation of mushrooms for food. L. C. C. Krieger, mycologist of the New York State Museum, published in 1936 a very informative volume—*The Mushroom Handbook*—with many photographs and coloured drawings of American mushrooms. In 1938, Sanshi Imai in the *Journal of the Faculty of Agriculture*, (Hokkaido Imperial University, Vol. XLII, Part 2) has dealt with Agaricaceae of Hokkaido where he remarked that 'the edible *Agarics* in Hokkaido comprise one hundred and

eighty one species and four forms. Among them, the fungi suitable for market are seventy four species and two forms'. In the *Philippine Journal of Science* (Vol. 65 Nos. 1-2, Jan.—Feb., 1938) J. M. Mendoza has elaborately dealt with Philippine mushrooms, their methods of cultivation, preparation of mushrooms for the table etc., with several plates. An article by Dr L. N. Seth (of Agricultural College, Mandalay) on the "Cultivation of Straw Mushrooms (*Volvaria diplasia*)" in Burma is, we understand, soon coming out in "Indian Farming" (Agricultural Research Institute, New Delhi) in course of the current year (1940).

In Bengal steps should be immediately taken for the cultivation of our local edible mushrooms by the Bengal Agricultural Department according to the lines suggested by Prof. Bose in the concluding part of his paper on "Possibilities of Mushroom Industry in India by Cultivation" in *Agricultural Journal of India*, Vol. XVI, Part VI, 1921.

RELIGION IN SCIENTIFIC ERA

THE entire history of the contact of religion and science shows that the facts of the world and of life which are capable of observation and test, constitute a realm in which science is supreme. Science has not supplanted and cannot supplant or destroy religion in the proper sense. It can, however, give a setting to which our thoughts on religious matters must conform. Science has continually forced men to take an ever wider and grander concept of religion by breaking down artificial barriers of ignorance and superstition. Its whole tendency has been to emphasize the fundamentally spiritual character of religion as representing the highest ideals and aspirations of mankind as opposed to theological rules, doctrines, theories, and so on. Science has therefore had tremendous influence in shifting the emphasis of religion from the physical to the spiritual world, and we must not shut our eyes to the possibility of still further powerful influence of this sort.

Science has thus helped to make religion into a developing, dynamic spiritual force. I believe that the principal influence of science upon religion has been along the following lines: first, to break down "authority" and substitute reason based upon facts of observation; second, to eliminate superstition and chicanery from religion; third, to doom any religion of the static type and emphasize the necessity for a continual development of religious thought to keep pace with and interpret the increasing knowledge regarding all matters which pertain to man's activities and environment.

—Karl T. Compton.

Radio Fade-Outs and Their Origin

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INTRODUCTION

A REMARKABLE type of sudden and violent disturbance to world radio traffic has in recent years received considerable attention, not only of radio engineers but also of physicists and astrophysicists. The disturbance, commonly known as radio fade-out, consists in the weakening or complete cessation of short and medium wave radio signals, lasting from a few minutes to about an hour or more, over the whole sunlit hemisphere of the earth. The "fade-out" (of short and medium wave signals) is accompanied by enhancement of long wave signal strength and of atmospherics and by other terrestrial effects. The magnetic field at the surface of the earth as well as the "earth currents" in the sunlit portion of the hemisphere are observed to undergo sudden changes. Simultaneously with these, intensely luminous patches are found to have developed on the solar disc.

The effects associated with the fade-out, though they have been receiving attention only in recent years, did not escape the notice of earlier solar physicists. We may mention, for instance, that a possible relation between bright solar patches and sudden variation of terrestrial magnetism was hinted about 80 years ago by an English astronomer Carrington who had observed visually patches of intensely bright and white light on the solar disc while watching sunspots on September 1, 1859 at 11h. 18m. G.M.T. Having no photographic arrangement at hand, he drew a sketch of the observed patches shown in Fig. 1. Two days later it was discovered that almost simultaneously with this solar appearance magnetogram records at the Kew Observatory had registered sudden abnormal changes in all the three magnetic elements. The simultaneity of the two events excited considerable interest at that time but no importance was attached to its possible significance as it was thought that the observed

coincidence of solar eruption and magnetic disturbance was a spurious one.

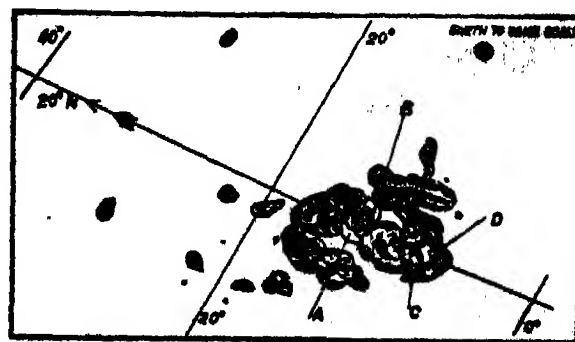


FIG. 1.

Appearance of bright and white patches (marked A and B) on solar disc as sketched by Carrington on September 1, 1859. It was subsequently discovered that simultaneously with the appearance of these patches the magnetogram records at the Kew Observatory had registered sudden and erratic variations of the magnetic elements. (The sketch was first made public by Balfour Stewart in 1861).

The immediate cause of the radio fade-out is a sudden change, detrimental to the propagation of short and medium waves, produced in the ionosphere—the radio roof of the world. Such changes are effected by extreme ultra-violet radiation emanated from the bright patches, called chromospheric eruptions, on the solar surface.

THE NATURE AND ORIGIN OF THE IONOSPHERE

In order to understand the various aspects of radio fade-outs it is necessary to have some idea of the nature and origin of the ionospheric regions which guide radio waves round the curved surface of the earth. The upper atmosphere extending from 50 to about 400 kilometres or even more, contains electrified particles such as electrons and ions. This vast electrified or ionized region, called the

ionosphere, is a conductor of electricity and reflects radio waves almost in the same way as a mirror reflects light.

The ionosphere is not uniformly ionized throughout its entire thickness. The concentration of the electrified particles is high in certain regions or layers between which they are relatively rare. This is represented pictorially in Fig. 2. It will be noticed that there are two main regions of very dense ionization. The upper one which has its densest portion at a height of about 250 km., is called Region F; the lower one situated at about 100 km. is called Region E. At a height of about 60 km. may be discerned another ionized region of much lower density; this is known as Region D. The relative distribution of electrons in the D, E and F regions is shown by the curve at the right of Fig. 2.

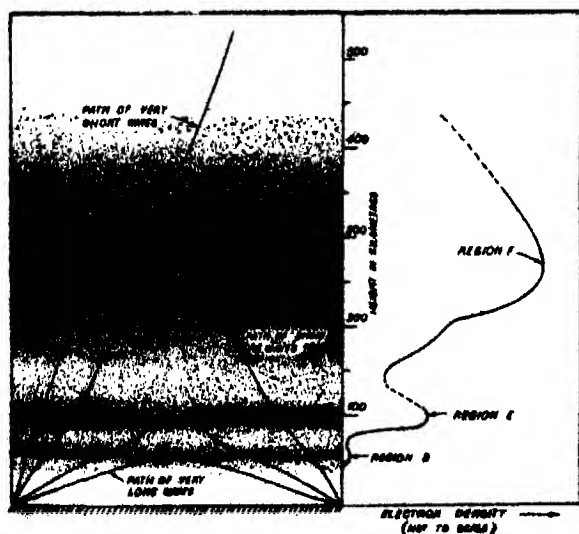


FIG. 2.

Illustrating the various ionized strata of the ionosphere and their relative ionization densities. Regions E and F are the reflecting regions and carry medium and short waves round the earth. Region D is reflecting only for very long waves; for short and medium waves it is absorbing.

It should be mentioned here that the ionized regions not only reflect but also absorb radio waves. The strength of absorption is dependent on the number of collisions which the electrons or ions make with the neutral molecules and atoms present in the medium per second. Thus an ionized region situated at a great height, where air density and hence the collisional frequency is small, causes little absorption of radio waves, while, a region located in the denser atmosphere below, where collisions are frequent,

causes considerable absorption. It is therefore evident that the higher regions E and F will act in general as reflectors and the lower region D as absorber of radio waves. The increased absorption of short and medium waves observed in daytime is, in fact, principally due to increased ionization of Region D caused by the solar rays during day light hours. Region D, however, reacts in a different manner towards long waves. For such waves, increase of ionization causes copious reflection instead of absorption. This is because the long waves are unable to penetrate into the region and are simply thrown back, as it were, from the lower boundary.

The formation of these electrified regions is due to the ionizing action of extreme ultra-violet radiation from the sun. The sun, it is believed, radiates like a black body at a temperature of 6500°C. As such one would expect its spectrum to extend far into the ultra-violet. Actually however the solar spectrum, as observed near the surface of the earth, ends abruptly at a wavelength of 2900Å. This is because the entire spectral region beyond this limit is absorbed by the upper atmospheric gases like ozone, molecular and atomic oxygen and molecular nitrogen. The absorption by these gases—of the different portions of the ultra-violet spectrum—leads to various types of photo-chemical, photo-ionizing and photo-exciting reactions. Of these we are concerned here mainly with absorption leading to ionization, i.e., knocking off of one or more of the outer electrons from the absorbing atom or molecule. It is obvious that the active radiations which produce ionization of the different gases will be extinguished by absorption at different levels depending upon the value of the absorption coefficient and the mass of gas traversed from the top of the atmosphere. If the coefficient is large, it is extinguished at a great height; if the coefficient is small it is fully extinguished only after it has penetrated down to very low heights. Each absorbing gas therefore produces its own region of ionization at a level which is determined by the strength of its absorption. The formation of the different ionized regions in this manner is further conditioned by the fact that the atmospheric gases are not thoroughly mixed up to the highest levels. The mixing exists only up to a height of about 100 km. The constituents up to this level are mainly molecular nitrogen and oxygen, and their proportion at any height is the same as that at the ground level. Above 100 km. molecular oxygen is split up into atomic oxygen. The constituents in the high atmosphere are therefore principally molecular

nitrogen and atomic oxygen. Unlike the gases in the region below 100 km., the two gases here are in a state of the so-called diffusive equilibrium; atomic oxygen being lighter occupies the highest levels floating as it were on the heavier molecular nitrogen below. Further, there is a region of transition lying between 80 and 130 km. levels within which molecular oxygen is gradually replaced by atomic oxygen.

We can now describe the formation characteristics of the different regions of the ionosphere pictured in Fig. 2. Region F is formed by the absorption of solar radiation at and below λ 660A by atomic oxygen.

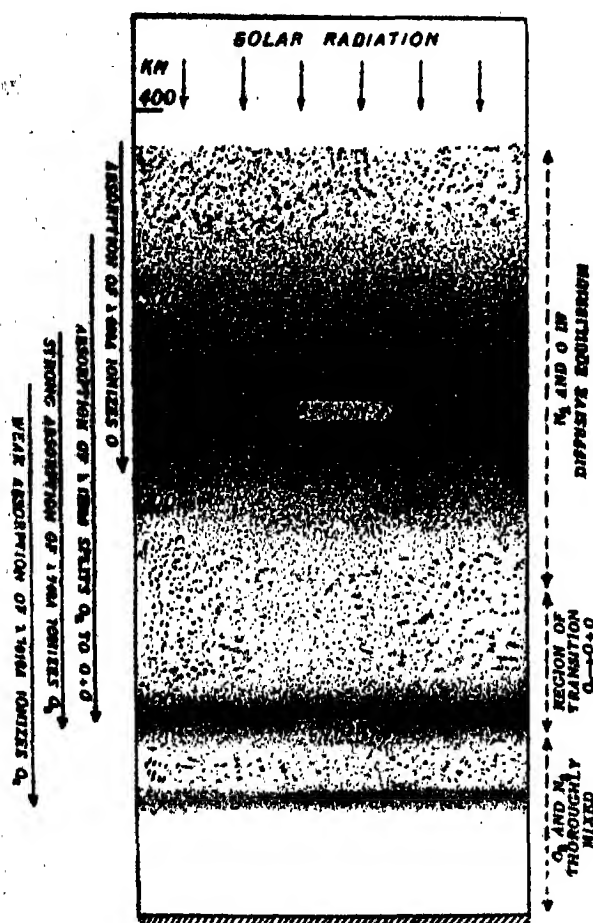


FIG. 3.

Illustrating the formation of the various ionospheric strata by absorption of different portions of the solar ultra-violet radiation.

The splitting of $O_2 \rightarrow O + O$, in the region of transition round the 100 km. level, is caused by the absorption of radiation at and below λ 1750A. Region E is produced in this region of transition by the absorption of radiation λ 774A and below by

molecular oxygen. Oxygen molecules also absorb, though rather weakly, radiation of wavelength at and below 1010A and are thereby ionized. This absorption is responsible for Region D at the 60 km. level.* The formation of these regions is pictured in Fig. 3.

It will be useful here to describe the ingenious experimental method by which the structure of the ionosphere described above has been discovered. A "packet" of radio waves of very short duration (a few ten-thousandths of a second) is sent up from a transmitter. This is reflected down by one or other of the conducting ionized strata of the ionosphere. If a receiver is placed at the ground not far removed from the transmitter, it will receive two signals due to a single wave-packet; one due to that portion of the wave which has travelled along the ground (direct pulse), and the other due to the portion reflected by the ionospheric stratum (indirect pulse) as shown in Fig. 4. The two received pulses are

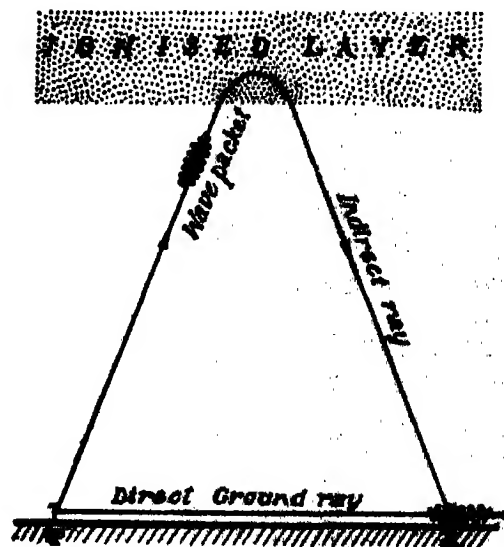


FIG. 4.

Illustrating the pulse-method of sounding the ionosphere. Trains of wave-packets are shot upwards from the transmitter (T). These, returned by one or other of the ionospheric strata, reach the receiver (R) a few milli-seconds after the corresponding packets travelling directly along the ground. The height of the reflecting stratum is easily computed from this interval. If the wave frequency is high, the wave-packet may pierce the stratum and fail to record any echo. The presence of an absorbing layer between the ground and the reflecting stratum may also obliterate the echoes.

* The absorptions of λ 1010A and λ 774A by O_2 both lead to ionization. The difference lies only in the state of the resulting ionized molecule. In the first case the molecule ionized is in its normal state whereas in the second case it is in an excited state. The energy required in the two cases are 12.2 and 18.6 electron volts respectively and are called the first and second ionization potentials.

separated by a time interval of the order of a few thousandths of a second and can be recorded on the screen of a cathode ray oscillograph. This interval is the time taken by the pulse to travel from the ground to the reflecting stratum and back. The velocity of radio waves being known (in free space it is equal to that of light, viz., 3,00,000 km. per sec.), the height at which the ionized stratum is situated is easily calculated from a measurement of this interval.

The "pulse method" of exploring the ionosphere also enables one to calculate the electron density in the various ionized regions. For this purpose the frequency of the wave is gradually increased till the wave packets pierce through the stratum and fail to record any echo. The frequency for which this occurs is called the critical frequency and is related in a simple way to the electron density of the stratum which is just pierced.*

Ionospheric exploration by this method has been found so helpful for collecting data for use in

connection with long-distance radio communication that quite a number of ionospheric observatories have been built in different parts of the world for keeping continuous records of the heights and the electron densities of the various ionospheric regions. The method of obtaining continuous records is shown in Fig. 5. G and E are respectively the direct and the indirect pulse reflected from an ionospheric region. With the aid of a suitable camera the pattern on the oscillographic screen is thrown on a continuously moving film. The whole screen is masked leaving only the horizontal line—the "time base". As the film slowly moves the bright horizontal line blackens the whole film leaving two gaps (shown by the two dark vertical traces) corresponding to the positions of G and E.

The separation between these traces gives the height of the reflecting stratum. If, at any time, the echo is absent for some reason or other, a discontinuity occurs in the trace. Records of this type are very useful for studying ionospheric conditions during a fade-out. We will now turn our attention to this.

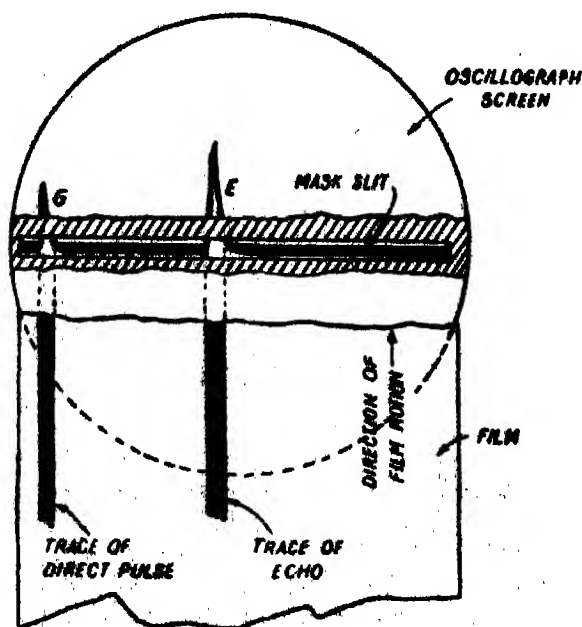


FIG. 5.

Illustrating the method of continuous recording of ionospheric echoes.

The shaded region is part of the mask which covers the whole of the oscillographic screen except the horizontal time-base. Any pulse appearing on the time-base brings in a discontinuity which leaves its trace on the moving film.

* The relation is $N = 1.24 \times 10^{-3} f^2$, where N is the number of electrons per c.c. and f is the critical frequency in kilocycles per sec. This relation neglects the effect of the earth's magnetic field on the propagation of the waves in the ionosphere.

SIMULTANEITY OF OCCURRENCE OF THE VARIOUS PHENOMENA

The simultaneity of the solar, radio, magnetic and earth-current effects during a fade-out is shown in Fig. 6. The spectroheliograms at the top of the Figure were taken at Mount Wilson Observatory on April 8, 1936 and show the appearance of a bright eruption at 16h. 49m. G.M.T. The ionospheric records made at Washington reveal that radio echoes ceased completely at 16h. 46m. G.M.T. The magnetic and earth-current records at Huancayo show sudden changes at the same instant. The phenomena which occurred on this date may perhaps be best described in the words of A. G. McNish¹:

"Routine observations with the spectrohelioscope were in progress at the Huancayo Observatory at the Carnegie Institution's Department of Terrestrial Magnetism at this time. The observer on duty noticed a remarkable brightening of the H-alpha light in the region of a large sunspot, beginning at 16h. 45m. G.M.T. This eruption was accompanied by certain terrestrial phenomena as shown in

¹ McNish, *Terrestrial Magnetism and Atmospheric Electricity*, 47, 100, 1937.

Fig. 6. The spectro-heliograms shown in the Figure were made at Mount Wilson before the eruption, while the eruption was at its maximum, and after the eruption had subsided. They show the brighten-

'from the viewpoint of extent and intensity' this was the most spectacular eruption which had been witnessed at the Observatory since beginning routine observations with the spectrohelioscope a year before.

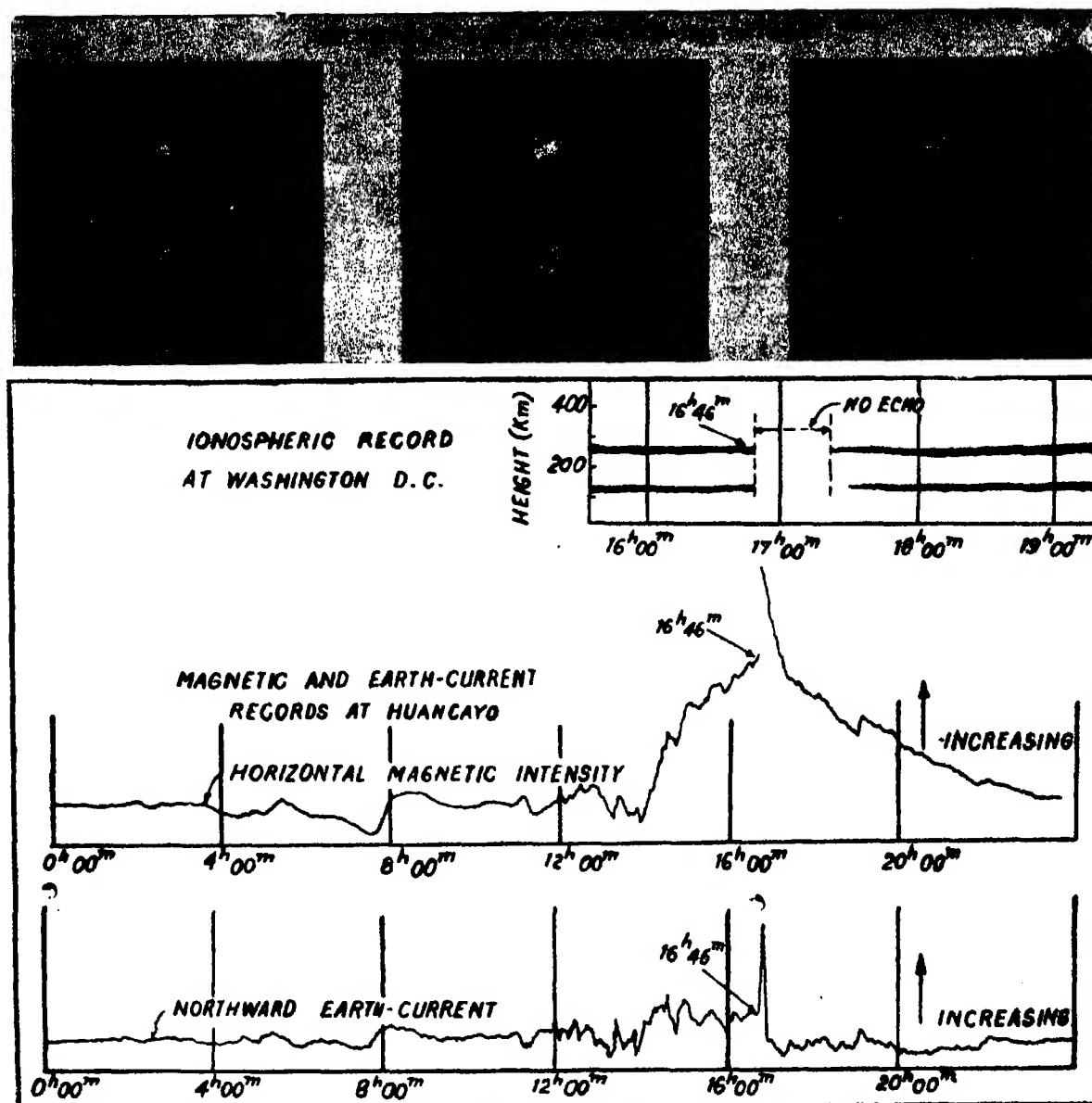


FIG. 6.

Illustrating the simultaneity of radio, magnetic and earth-current disturbances and the appearance of bright patches on the solar disc. The ionospheric record shows complete cessation of echoes from the ionospheric regions E and F at heights 110 and 260 kms. during the appearance of the bright solar patches. At the same time the magnetogram and the earth-current records show sudden increases in the value of the horizontal magnetic intensity and of the earth-current.

ing of the sunspot, although high contrast of the negatives used permits little discrimination regarding intensity. The observers at Huancayo reported that

"Ignorant of the solar fireworks in progress, the radio operator at the station, who was engaged at the time in making measurements on the ionosphere,

found it impossible to receive reflections on any frequency and began to search for defects in his equipment. Finding none, observations were resumed" and the echoes returned 55 minutes later. "The sudden changes in the Earth's magnetism and in the earth-currents which are continuously registered at the Observatory are conspicuous in the records at the bottom of the Figure. It may be noted that all the terrestrial effects began at 16h. 40m., one minute after brightening became perceptible in the sunspot-region."

Such simultaneous occurrences of the various phenomena—solar eruption, radio fade-out, terrestrial magnetic and earth-current disturbances—have been observed on numerous occasions. There are, however, instances on record of the occurrence of a radio fade-out with no accompanying solar eruption and, conversely, of the appearance of a solar eruption without fade-out effects.

RADIO AND MAGNETIC EFFECTS

We will now discuss in some detail the radio and the magnetic effects associated with a fade-out.

Radio Effects: The most spectacular aspect of the radio effect is, as already mentioned, sudden cessation of wireless traffic on short and medium waves. The other effects are enhancement of long wave signal strength and increase of atmospherics. (The latter, as is well-known, have a quasi-periodicity of the order of a few thousand cycles per second). Figure 7 shows the sudden rise in the atmospheric disturbance during the fade-out which occurred on April 8, 1936 when the recording equipment was tuned to 27 kc./sec. (11,100 metres). The inset shows that the nature of the increase of the strength of atmospherics is very similar to that of the decrease of short wave signal strength. The curve is a record of the intensity of long-distance signals on 9570 kc./sec. (3134 metres) and is drawn with the ordinate reversed—a rise in the curve signifying a decrease of the intensity—to emphasize the similarity in the forms of the two curves. These effects receive an easy explanation if it is assumed that radiations emitted from the bright patches cause a sudden increase in the ionization of Region D which, as mentioned above, absorbs short and medium waves but reflects very long waves.

Earlier observations seemed to indicate that the ionospheric layers lying above Region D are

unaffected during a fade-out. Recent observations made in Australia show, however, that changes in Region F do occur during a fade-out. These changes are firstly, a small diminution of the electron density and secondly, an increase in the height of Region F. Further, it is found that although the

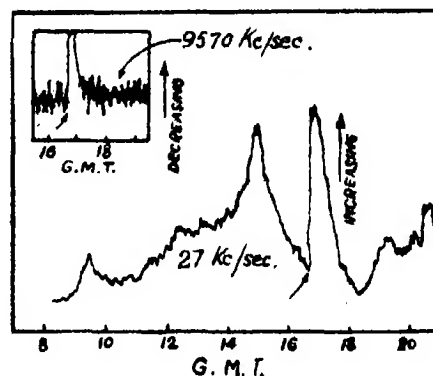


FIG. 7.

Illustrating intensification of long wave and disappearance of short wave signals during a fade-out. The arrows indicate the commencement of the fade-out which occurred on April 8, 1936.

fade-outs occur usually after the commencement of the chromospheric eruption (sometimes as long as 2 hours later), the changes in Region F begin almost simultaneously with it.

To summarise, the main effects associated with a fade-out are:

(i) An intensification of the ionization in the absorbing Region D.

This, on the one hand, obliterates radio echoes on short and medium waves (reflected by the upper ionized strata) and, on the other hand, strengthens the very long wave signals (reflected from Region D itself).

(ii) A small diminution of the ionic density and an increase in the height of Region F.

Magnetic Effects.—The magnetic effect, as mentioned above, consists of sudden changes in the magnetic elements notably in the horizontal magnetic intensity H. In Fig. 6 it will be noticed that H increased so much that for a few minutes the recording instrument failed to register its value. Detailed examination of the magnetic records during fade-outs shows that the change in the magnetic field for each observatory consists simply of an augmentation of the ordinary quiet day variation of each of

the magnetic elements (see *SCIENCE AND CULTURE*, p. 70, August, 1940). The magnetic changes are most noticeable in the observatories situated on the illuminated hemisphere of the globe; observatories at a distance of more than 70° from the sub-solar point scarcely show any measurable effect.

The above observations on magnetic and radio effects during a fade-out are of utmost importance in deciding between the three rival theories—drift-current, diamagnetic and dynamo theories—of the origin of the world-wide current system in the high atmosphere producing the diurnal terrestrial magnetic variation on a quiet day. According to the drift-current and diamagnetic theories the current system must lie in a region of the ionosphere where the frequency of collision is small, *i.e.*, above 100 km. According to the dynamo theory, however, the current system must lie in a region of high collisional frequency, *i.e.*, below 100 km. Now, as pointed out, the magnetic effect observed during a fade-out is merely an enhancement of the normal diurnal variation. It therefore follows that the cause of this enhancement must be an intensification of the current system producing the normal diurnal variation resulting from increased conductivity of the region in which it flows. Since, at the time of a fade-out, it is the ionization of Region D—the region of high collisional frequency—which is increased it may be concluded that the quiet-day diurnal variation current system flows in this region. This is therefore a strong evidence in support of the dynamo theory as against the other two theories.

ORIGIN OF THE FADE-OUT EFFECTS

From what has been said above there is little doubt that the immediate cause of the radio fade-out and of its associated effects is a sudden increase of ionization in the absorbing Region D of the ionosphere. The increase is caused by ultra-violet radiation emanated from the bright solar spots. In order to be complete and satisfactory this hypothesis must, however, explain all the observed details of the effect. For instance, it should explain:

(i) Why all observed solar eruptions are not accompanied by fade-outs and why during some fade-outs no bright solar eruption is observed?

(ii) What is the likely process by which the ionization below the E layer is increased?

(iii) What are the constituents of the atmosphere which are affected and by what wavelengths?

(iv) How does the ionic density of Region F decrease?

These are the points which the hypothesis should explain besides the origin of the primary cause, namely, the bright eruption.

With regard to (i) the natural explanation is that the solar eruption must attain a certain minimum intensity before it is able to produce increased ionization causing the fade-out. In previous observations little attention was paid to the intensity of the eruption. If one compares eruptions which are accompanied by fade-outs with those which are not so accompanied one cannot detect any difference between the two except that the former are brighter than the latter. If the intensity is designated on an arbitrary scale 1, 2, 3 of increasing intensity it is found that practically all eruptions designated as intensity 3 are accompanied by radio fade-outs.

Regarding the converse phenomena, namely, radio fade-outs unaccompanied by solar eruption, one ought to take account of the fact that all radio fade-outs reported as such may not be really so. It might be recalled in this connection that, so far as the effect on Region F is concerned, the decrease of ionization occurs almost simultaneously with every solar eruption.

With regard to (ii) and (iii) it is sometimes suggested that the radiation which is responsible for the production of Region E (λ 744A), if intensified, might produce stronger ionization in the absorbing stratum below this region. This is hardly possible; because, the main effect of intensification of this radiation will merely be an increase of the ionization density at the level of Region E without any appreciable increase below. We have, however, already mentioned that during a fade-out, Region E ionization is affected very little if at all. It thus seems certain that the radiation causing fade-out is distinct from that which is responsible for producing Region E ionization. The probable nature of such radiations has been suggested by several authors and are discussed below.

The emission of the Balmer H-alpha line from an eruption must be accompanied by the Lyman lines of hydrogen. The wavelengths of the Lyman lines are such, that with certain plausible assumptions

in regard to the atmospheric constituents in the Region F and below the Region E, the decrease of ionization in the first and the increase of same in the second can be explained.

From what has been said above it is evident that below the Region E, between 60 and 100 kms., both O_2 and O are present. According to one view^{1, 3} the increase of ionization in this region is due to the ionization of molecular oxygen and according to another view⁴ to that of atomic oxygen. For reasons to be given presently it seems almost certain that the constituent affected by ionization is O_2 and not O.

Since the first ionization potential of O_2 is about 12.2 electron volts, it is evident that the ionizing wavelength must be equal to or below 1010Å. The wavelength of $L\beta$ being 1026Å (greater than $\lambda_{1010\text{Å}}$), the ionizing radiation should be $L\gamma$ ($\lambda_{973\text{Å}}$). Absorption of this radiation, however, is relatively feeble and, as a consequence, it will be completely absorbed only after it has penetrated down to a considerable depth below Region E. Calculations made by Mitra, Bhar and Ghosh² on the assumption that the absorption coefficient of O_2 for this radiation is only one-thousandth of that for $\lambda_{744\text{Å}}$ (corresponding to the second ionization potential of O_2) show that the maximum ionization due to this absorption occurs at a height of about 55 km. It may therefore be concluded that a solar eruption accompanied by an intensification of the Lyman lines of hydrogen enhances the ionization of the absorbing Region D which lies at this height.

According to another view³ the enhancement of ionization is due to the action of $L\alpha$ on atomic oxygen which is assumed to be present in sufficient quantity even down to 60 km. The possible process of ionization suggested is as follows. Atomic oxygen is excited by the absorption of the $L\alpha$ line.

Such an excited atom may lose by collision an electron and an amount of energy of 0.75 electron volts, and thus revert to the normal state of ionized oxygen atom. For this to happen the number of collisions must be sufficiently high and the process will therefore occur at comparatively low levels. This hypothesis might, however, be criticised on the following grounds. In the first place the collision, in order to produce ionization must have to be sufficiently violent. It is questionable whether such violent collisions can occur in the relatively cool atmosphere of Region D. Secondly, calculations show that atomic oxygen, the presence of which is essential for this process to occur, cannot be present abundantly in this region.

In order to explain the decrease of the ionization density of Region F, observed during a fade-out, the presence of water vapour in this region is assumed. The temperature here is high—of the order of 1200° to 1500°C. Now, it may be shown that the equilibrium temperature of this region, if it consisted of atomic oxygen only, would be considerably higher—about 3500°C—due to the absorption of solar ultra-violet radiation of wavelength 1450Å. If, however, water vapour also is present, the rise would be considerably less owing to the fact that water vapour is a good radiator of heat and the temperature would lie between 1000° and 2000°C. The assumption regarding the presence of water vapour in the high atmosphere thus appears to be justified. The $L\alpha$ radiation which is strongly emitted during solar eruptions dissociates the molecules of the water vapour to H and OH (excited). The temperature of the region therefore goes up because water vapour is no longer present to check its rise due to the absorption of $\lambda_{1450\text{Å}}$ by the oxygen atoms. The atmosphere therefore expands upwards and its density decreases. Ionospheric observations thus show a decrease in the ionic density of Region F and an increase of its height.*

¹ Mitra, Bhar and Ghosh, *Ind. Jour. Phys.*, 12, 455, 1938.

² Saha, *Proc. Nat. Inst. Sci. Ind.*, 5, 21, 1939.

³ Martyn, Munro, Higgs and Williams, *Nature*, 140, 603, 1937.

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The Problem of Food Adulteration

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THE question of pure food supply is a pressing problem in India. It is even more important than the problem of drug control. It is obvious that if adulterated and injurious food constitutes the major portion of the common dietary that is consumed from birth till death, even pure drugs can avail but little. As a matter of fact, the trade in adulterated food has assumed the proportions of a scandal in this country. What is worse is that it is particularly the staple or the more commonly consumed food-stuffs that suffer from the most unscrupulous adulteration. In Bengal, for instance, *atta* (whole wheat flour), *moinda* (white flour), *ghee* (clarified butter), mustard oil and milk are the principal commodities that are most highly adulterated. This adulteration is carried out on a large scale and very frequently with the help of expert scientific advice. For this purpose even small laboratories and machineries for grinding soapstone, gravel, etc., are maintained by the dealers concerned. As it is, the diet in most parts of India including Bengal is very ill-balanced and defective and if, in addition to that, adulterants, like soapstone, unwholesome fats and other toxic substances find their way into the stomach, the resulting situation can be well imagined.

Not that attempts at checking food adulteration have not been made. So far as Bengal is concerned, the Bengal Food Adulteration Act of 1919 was designed to prevent adulteration. But the measure has largely failed because firstly the Act itself has not been sufficiently comprehensive and had several lacunae. Secondly, the inspecting staff and others responsible for the enforcement of the Act have not always been sufficiently mindful of their civic duty. Thirdly, the ingeniousness of the dealers in the matter of adulteration has often defeated the ingeniousness of the scientists of the public health

laboratories. One should also realise that the mischief is done more by the whole-sale dealers who release the commodities into the market ; the retail dealers are perhaps somewhat less to blame.

The Bengal Pure Food Bill of 1940 which has just been brought before the Bengal Legislative Assembly for enactment seeks to remedy some of the defects of the Bengal Food Adulteration Act of 1919. This is a desirable step. The Bill seeks to control the places where large scale adulteration is carried out which was not so easy under the old Act. It attempts also to remedy some of the defects of the old Act which have been revealed in the course of its operation during the last 20 years. But it should be fully realised that the success of the new Act would depend chiefly on the rules and bye-laws regarding standards of purity, etc., which will be framed later on by the Bengal Government under the provisions of the Act. The rules to be framed for such purpose demand a considerable amount of knowledge and scientific experience. In this country before now practically no attempts have been made by the Government to seek any advice other than that of their official experts in framing such rules concerning the limits of purity and the methods of analysis to be pursued. The Government experts have no doubt their qualifications. But the tendency has been to copy the standards and methods from those of other countries in a stereotyped way. While the right course for us is to adopt the methods of more advanced countries as the base line for our efforts, the food practices and food adulteration processes of our country require adaptations of those methods to our local conditions. Nor should it be forgotten that our knowledge of methods of analysis is progressive and a set of procedures adopted to-day is capable of considerable improvement tomorrow. This leads to the corollary that we must in the long

run depend on ourselves and the experience and researches of our public health laboratories together with those of the scientists in universities and other research institutions should provide the guide to the framing of the rules referred to above. In this country the necessary pooling of information between the public health laboratories doing analytical work and other research laboratories which have sometimes more competent personnel has not taken place. On such vital questions the opinion of expert scientific bodies like the Indian Chemical Society and the Institution of Chemists (India) should also be invited. As an instance of the relative detachment of the ordinary Government expert from other experts outside the pale of Government service we may cite the case of "Agmark Ghee". With reference to that commodity sufficient help has not been sought by the department of the Central Government concerned from scientists of universities, who have something to do with food technology or from an influential body like the Indian Chemical Society, which could bring to bear a considerable amount of scientific knowledge on the problem in question. As a result, in the opinion of many experts, the standards set up by the Government for the aforesaid ghee are not sufficiently satisfactory. We would therefore urge upon the Bengal Government to circulate the Bengal Pure Food Bill to non-official scientists and scientific organisations and also to invite their opinion on the framing of the rules regarding purity, standards and methods of analysis. Much depends upon this.

The present measure that the Bengal Government is adopting concerns also the organisations of the public health laboratories and the question of public analysts. As we have said before, the knowledge of analysis is not in a static condition and the personnel of the public health laboratories should be such as cannot only carry out routine analyses but can also look at the problem of adulteration as a research problem so that new and more accurate methods may be devised to meet the local situation arising from the use of local adulterants which are peculiar to India. Mere copying of methods from standard books of analysis will not do. This requires that the scientific personnel of these laboratories should be well-paid and that there should be no nepotism in their appointment. They should be both able and above corruption. It is therefore desirable that all the District Public Health Laboratories, which are now run by District Boards, should be provincialised and should come more or less into the same category as the

Public Health Laboratory of the Government of Bengal. The selection of the personnel should be left entirely to the discretion of a body like the Public Service Commission entirely uninfluenced by considerations other than that of the need of promoting the public health of the province. It should be fully realised that, if irrelevant considerations come into the picture and wrong appointments are made, more harm may be done through the new Act than good.

The question of public analysts is again a matter in which India is much behind the times. In all other countries it has been realised that the public analysts should be trained chemists or persons who have passed a rigid test concerning food analysis in all aspects. Dr G. E. Oates, Medical Officer of Health of the Metropolitan Borough of Paddington thus observes: "In most of the towns, however, the medical officer of health is responsible for this branch of public work (*i.e.* administration of the Food Adulteration Acts), and in order to obtain his qualifying diploma in public health he will have to pass a somewhat exacting test of his knowledge of food analysis. Needless to say, this in no way qualifies him to act as public analyst, the qualifications for this appointment involving a long and arduous training and a difficult examination test". It will thus be seen that a medical officer of health who has passed a good test for food analysis is, nevertheless, not considered competent to discharge the duties of a public analyst. It is high time that this was fully realised by all provincial Governments in India. In many places it is still the medical officer with no special knowledge of analysis who is still officially the public analyst and simply signs the analytical reports submitted by the chemist of the public health laboratory. When a prosecution results from the administration of the Food Adulteration Act, it is the actual analyst who has to submit to cross-examination. The position is obviously anomalous and is symptomatic of the general backwardness of our country. There is no harm of course in appointing medical people as public analysts if they have undergone the arduous chemical, bacteriological and other special training to which Dr. Oates refers.

We would also suggest that, even after the rules and standards are framed by co-operation and exchange of information between official and non-official experts, a permanent committee consisting of both these classes of experts should be set up by the Government for the purpose of directing researches on the question of standards, limits of purity and

methods of analysis. This kind of investigation is essential for solving our problems of food adulteration. Such a committee may be called the "Pure Food Technical Committee" and should undertake a comprehensive survey and investigation of the technical problems connected with food adulteration. This work should be carried out in perfect co-ordination between the public health laboratories and

university and other laboratories, willing to participate in the joint endeavour. This Committee would be the most suitable both for formulating the problems to be attacked and for directing efforts at their solution. We hope that while the new Bill is on the legislative anvil, the considerations set forth above will receive due attention from the Government and the Legislature.

EFFECTS OF ENGINEERING IN PRESENT AGE.

In our present state in the western world we have reached an age when the effects of engineering run through all conditions of living. We of the western world have so profited by active prosecution of scientific discovery, invention and refinement of engineering processes that our conditions of life for all but the most wealthy are in strong (indeed startling) contrast with the woeful conditions of living available for the poor and the moderately well-to-do in those eastern countries which have failed to participate in such developments. We have further improvements to make. For illustration, it is a fact that we have not yet developed the human contacts, in those of our industrial organizations in which production by machines is prominent, so as to reproduce the friendly responses that are possible among industrial groups, and which were observable in the best of old-time hand-work conditions. Such defects, however, gradually become rectified as the modified social relations gain recognition.

Engineering processes and engineering devices have been (and are being) abused by use in warfare, and much of the poverty now found in various nations is an aftermath of costly wars which sacrificed productive men and valuable property.

It is not science or engineering which is at fault. The defects in human relations which arise in our day in local, national and international affairs are not due to faults in the fundamental ideal of a complete civilization, nor to a scientific engineering which has set up and continues to maintain the stage for a possible realization of that ideal. The fault lies in the lag of human intelligence with respect to its opportunities for bettering human conditions. The human mind, in mass, is very slow to change in character; and stable improvements of mutual relations cannot be rushed to success by the vaguely applied efforts of professional reformers or dilettantes in social affairs. Such improvements may only be successfully produced slowly in association with sounder-growing mass-thought regarding living affairs in both material and ethical relationships.

Such processes are fraught with alternate states of success and discouragement. The influence of engineering is of primary importance for showing the ways to material betterment. Following in the wake of material betterment and increased leisure which are secured by improved engineering practices, intellectual improvement also usually comes as an ultimate contribution to social welfare.

Notes and News

Petroleum Supply of the World

It is generally believed that petroleum supplies are limited and irreplaceable and it has been computed by competent specialists that unless other new oil fields are discovered the present total world reserve would not last out more than only another 16 years. Contrary to the above belief Dr Gustav Egloff, of the Universal Oil Products Company of America, holds out the hope that petroleum is being continually formed underground on a substantial scale and even perhaps at a faster rate than human efforts are bringing it to the earth's surface. Though Dr Egloff cannot as yet claim to have fully substantiated his theory, his inference is based on the fact that there is a remarkable resemblance between some present-day fishes and molluscs found in abundance in lakes, rivers and oceans and those found in oilbearing formations. For example, in the Californian oil fields' geological formations are found fossils of plants identical with the microscopic plants known as diatoms now living in the seas. These plants are found to contain nearly 2% oil, and it is probable that even now these plants are being deposited in large quantities into what will be our future oil fields. Incidentally Dr Egloff forecasts that our oil wells in future will have increased depth of four to five miles as compared to the present depths of two to three miles.

Sulfanilamide as Promoter of Plant Growth

THE chemical sulfanilamide, which has proved to be a potent remedy for many human germ diseases due to checking the growth of bacteria, has now been found to possess other important properties having a bearing upon the growth of plants. The *Science News Letter* has published a report of some recent discoveries made by Dr Ernest L. Spencer of the Rockefeller Institute, who has observed that the chemical stimulates the growth of tobacco plant roots. Plants receiving from 20 to 40 parts per million of sulfanilamide were found to develop new roots much earlier than similar plants which did not receive a dose of the chemical. But uncut seedlings were not

found to be stimulated and a dose of the chemical which stimulated root formation on cut plants was found to poison plants with normal root systems. This behaviour has not as yet been properly accounted for. If sulfanilamide is to be attempted as a cure for some forms of plant diseases, Dr Spencer thinks, it must be used in much smaller doses than can be safely used in treating human patients.

Collection of Archaeological Materials in Karnatak

A RICH collection of historical materials has been made by the Archaeological Survey of India as a result of a village-to-village survey of inscriptions in the districts of Bombay Karnatak for the last 15 years. The material is now being published and a further search is being made for materials other than inscriptions. The Director-General of Archaeology has suggested to the Government of Bombay the establishment at Dharwar, at the earliest possible moment, of a properly constituted museum, which will focus efforts hitherto made by research workers in Karnatak. There is ample material for such a museum, e.g., rare manuscripts, sculptures and archaeological material from the earliest period of human history to the times of the Vijayanagar Empire.

A surprisingly large number of bronze images, copper plates, stone images, and minor antiquities have already been collected from different parts of Bombay Karnatak, which may be used as the nucleus of the proposed museum. The Director-General of Archaeology has also promised to use his good offices in procuring loans of archaeological material from other parts of India, so as to enhance the scientific and educative value of the collection.

The Government of Bombay have lately started a Kannada Research Office in Dharwar, and a director and two research fellows were appointed in October last. A programme of research work to be done by the Office was laid down in consultation with the Director-General of Archaeology, who also loaned the services of a trained scholar for appointment as director of research.

Control Problems in Sukkur Canals

THE Central Irrigation and Hydrodynamic Research Station, Khadakvasla, Poona, has succeeded in devising means to control silting of the Sukkur Right Bank canals, which has for some time past been a source of considerable anxiety to the authorities in Sind. The scheme evolved provides for a curved approach channel 5,000 feet long from its nose to the Sukkur Barrage and 2,250 feet long from the nose to the off-take, with a raised sill at the entrance to the pocket. The scheme has been tried on models, and experiments have shown that with this approach channel bed silt can be controlled as desired. Further experiments to determine the best methods of working the approach channel are in progress.

The Sukkur Barrage spans the River Indus about three miles downstream of the gorge between Rohri and Sukkur. In the middle of the gorge there is an island. Four canals take off from the left bank and three from the right. Upstream of the gorge the river is unstable and swings within a width of 15 miles but is fairly stable between the gorge and the Barrage. In this length the river is slightly curved in plan, the left bank being concave and the right bank convex. It is known that where a canal takes off from the convex side of a bend, the canal draws bed water and a relatively high charge of silt. The right bank canals at Sukkur being on the convex bank of the river have thus unfavourable conditions for silt exclusion. As was foreseen, a silt bank was formed along the right bank. In the floods of 1936 the sand bank reached an immense size and silting occurred in the North West Canal.

The proportion of the discharge of the river which passes through the right and left branches of the gorge upstream of the Barrage varies from year to year according as the main stream shifts to one bank or the other. In 1938, the main stream shifted to the left bank of the river and the right gorge then drew only 20 per cent of the total discharge. Based on this observation, experiments were carried out on the model and it was found that the less the proportion of discharge passing through the right gorge, the less was the quantity of silt moving along the right bank into the right bank canals.

This method was however considered unsatisfactory as it did not ensure full control of the discharge and curvature of flow. The new design of an approach channel was thereafter devised.

The National Physical Laboratory

IN spite of the disturbing effects of the war there has not been any great falling off in the amount of

useful work done by the National Physical Laboratory during the year 1939, as would be evident from the annual report of the Laboratory for the year 1939. In addition to experimental work done for and the advice given to various industries for immediate purposes and for long-range projects for opening up new possibilities, the laboratory carried on its usual routine work of testing of instruments and maintenance of exact standards of measurements. Additional new problems raised by the war also had to be tackled. Important investigations on the physical properties of carbon steels, light aluminium and magnesium alloys, ship propellers, new aircraft, the reduction of sound transmission in buildings, electrical insulating materials and the propagation of ultra-short radio waves were carried out during the year. Members of the staff gave lectures on the work of the laboratory at various centres as in other years, largely participated in the work of different technical committees and attended international conferences on scientific and technical questions abroad.

Annual Report of the Royal Observatory, Greenwich

THE Astronomer Royal's report of the work of the Royal Observatory, Greenwich for the year ending May 1, 1940 was presented to the Board of Visitors. On June 1, the war affected numerous activities of the observatory. The 28-inch refractor and the 26-inch refractor were dismantled for safety and work on both ceased from September 1939. Spectrographic work with the Yapp reflector (36-inch) however was continued. The expedition planned by the Observatory to observe the total solar eclipse in South Africa on October 1, 1940 had to be abandoned because of the war, but the Royal Observatory is going to send some equipments together with spectrographic instruments from the Solar Physics Observatory, Cambridge, for use by the combined expedition arranged by the Royal Observatory of Cape of Good Hope and the Union Observatory, Johannesburg.

The solar activity throughout the year was studied which seems to establish conclusively the downward trend of the 11-year cycle after the very high maximum observed in 1937-38. The relationship between bright chromospheric eruptions and magnetic storms has been studied at Greenwich during the past year. Magnetic and meteorological observations of a routine nature were continued as in previous years. During the year 30 magnetic storms were recorded of which 7 were 'great' and that on March 24 ranks among the greatest storms of the past century. As in last year's report, in this year's report the Astronomer Royal made reference to the deterioration of the conditions for astronomical observations at Greenwich and for the urgent necessity

for removal to a site where conditions would be more favourable. The increasing magnetic disturbance at Abinger where the magnetic observations are recorded, due to development of electric traction, requires the removal of the observing station from the present site if any high precision is to be obtained. A number of possibilities have already been examined but the plans for removal have necessarily to be deferred till the conclusion of the war.

Following Civilisation by "Myths" and Metals

ACCUMULATED facts on the basis of excavations primarily have provided grounds for classifying ancient tales as real history. The claim of folklores to be regarded as basis of historical facts becomes all the more strong when these records of the past are uncontaminated by foreign influence. The Biblical myth of Deluge has now been interpreted as a result of excavations in Mesopotamia where remains of that historic event have been discovered. Folklores are now supplying much information about the ancestry and the prehistory of people who lived at a very distant date. Two collections of folklores known as *Elder Edda* and *Younger Edda* (since translated in English) constituted one side of the picture of the people living in that part of Europe. The other side has now been furnished by scientific investigations. In an article in a recent issue of the *Technology Review*, the history of north-western Europe as preserved in these time-old ballads has been correlated with recent archaeological and ethnological investigations. The ancient Teutonic races who lived in the north-western part of Europe had migrated towards east about 1000 A.D. and a large number of them from Scandinavia settled in Iceland. The above verses were collected in that island and are today taken to narrate the history of north-west Europe during the period between the years 2000 and 400 B.C. In these remote ages climate and physical environment helped to a large extent the birth and growth of civilisation at a particular place and in its later stages it is found that use of more and more metals marked the future developments.

In northwestern Europe about 2000 B.C. the climate was mild and dry and the levels of lakes gradually dropped exposing surfaces for human habitation. The people living around gathered together, built villages and cultivated lands. At this period bronze was the material for tools, utensils and weapons. Iron was a curiosity, and contaminated with nickel it was procured exclusively from meteorites. Bronze being a man-made alloy of copper and tin, searches had to be made over long areas for these two metals which were evidently obtained in alluvial forms. This stimulated long-distance trade

contracts. In France alone from the sites of Bronze Age culture 48,000 bronze axes have been found. After a few hundred years the easy and simple life of the people received a rude shock when a terrible winter had set in at about 750 B.C. This date has been determined by studies of bog growth in Switzerland and Ireland and of growth of tree rings. The climatic wrath disintegrated the peaceful society of north-west Europe. During this wet cold period the sea shore of western Europe gradually settled down submerging many of the great Bronze Age megalithic monuments. Some of these have been reported to be visible at a very low tide. The oak and beech forests were replaced by spruce and the bogs deepened. People fled to the central and eastern European forests. Both these happenings of the birth of villages on the shores of the lakes and of the "Fimbul-winter" which destroyed the village life, are very vividly described in verse in the *Elder Edda*. The refugees from the north to the lower parts of Europe could not unfortunately stand against the iron-weaponed people living there. The first phase of the history of these people thus came to a close.

Bronze was now to be replaced by iron. The iron ores were first smelted by the Hittites living in Asia Minor. These people were known only in the Bible even as late as 50 years ago. Baked clay tablets discovered at their capital city near about the present Anatolia led to a series of excavations and investigations which have revealed the history of these people. This discovery of the use of iron by them was probably due to two causes. The first was the easily visible deposits of iron as exposed by erosion of rivers and the thickly wooded forests which made the production of charcoal a simple matter. Added to this was the strength of the Hittites with their big stone hammers, who were quite fit for manipulating the massive iron deposits into the furnaces. Gradually when trade flourished, iron found its way to distant places and Tutankhamen's Tomb dated 1350 B.C. revealed many important iron objects. About 1200 B.C. the Phrygians drove the Hittites from their homeland and the art of smelting iron spread to the neighbouring countries where the Hittites took shelter. At about 900 B.C. Iron Age in Europe was ushered in by those settling in the central Danubian basin, containing large deposits of iron ore. The Hallstatt period of Iron Age owes its name to a place in Austria where hordes of iron objects were dug out in 1846 A.D.

Researches on Indian Forests

THE work of the Imperial Forest Research Institute, Dehra Dun, done during the year 1938-39 has been outlined in the report entitled *Forest*

Research in India and Burma, 1938-39, Part I. In the report the activities in the different branches, viz., silviculture, botany, entomology, utilisation, chemistry, timber development, have been dealt with. Many important investigations in each of the branches received due attention as far as funds and time permitted. These are natural regeneration, investigation on seeds, investigation on trees and crops of timber plants, artificial regeneration, nursery work, reclamation and afforestation under the silviculture branch; progressive studies in systematic botany, and mycology were continued under botanical branch of investigation, and studies of insects attacking some useful timber trees under the entomological branch. In the utilisation branch the subjects of study included wood technology, timber testing, wood seasoning, commercial installation, air seasoning, shuttle-making trials, wood for battery separators, wood for cricket bats, wood for pencil and wood preservation, and paper pulp investigation proceeded under paper pulp section and researches on plants having insecticidal properties and on plants yielding oils and fats were carried out in the branch of chemistry. There has been quite a large number of publications during the year by the research workers in each of the different sections. Some of these publications are of considerable value in the maintenance of the vast forest areas and in the utilisation of a large number of forest products of the country. From these various subjects of investigation it will be clear that there exists an unlimited scope of prolonged research works in many directions, the results of which will lead towards economic utilisation of India's timber and other forest products. It is gratifying that in addition to lecture work the staff at the Forest Research Institute have done valuable work both on pure and applied aspects of various investigations throughout the year.

It is quite natural that the growing interest of the Indian public in the industrial development of their country urge them to call upon the scientific experts and research workers in the various Government departments for their advice. There is no doubt that the impetus to the indigenous industry as given by the constitutional changes and in the wake of the industrial and scientific advancement in the world at large has been reflected in an increasing number of enquiries. It is stated in the general review that "questions connected with the manufacture of paper and plywood were probably the most numerous, but smaller industries such as the making of pencils, umbrella handles and cigarette holders, as well as enquiries regarding suitable woods for semi-industrial purposes, such as the use of bamboos as reinforcement in concrete structures and

the chemical values of a large range of minor forest products, to mention only a few of the subjects upon which information was sought, kept the staff extremely busy during the year." It is all for the good of the country. The more the work of the department is utilised for the benefit of the country, the more it is encouraging for the workers themselves. It is curious however that some of the established scientific departments of great importance to the State received rather a setback instead of impetus for expanding their activities on proper lines along with the world progress. Undue pressure over the experts and research workers tells upon the health and energy of conscientious workers and it thus gradually leads to inefficiency. This has been hinted by the President, Forest Research Institute and College, Dehra Dun, in the general review. He rightly remarks, "Almost all provinces now employ an officer engaged solely on the investigation of silvicultural problems. The co-ordination of their work, as exemplified in working plans, and advising on complex statistical requirements to ensure significant results from the large volume of research work initiated by these specialists, taxed the staff of the Silvicultural Branch at the Institute to a degree which showed more clearly than ever that to continue with a staff no larger than that provided in 1924 was impossible without accumulating ever increasing arrears of work. That the heavy pressure of work was not confined only to the officers concerned with special lines of research, but extended throughout the whole Institute from the President down to the most junior subordinates, is a fact confirmed *inter alia* in a report submitted by Dr S. S. Bhatnagar to the Government of India."

It appears however that some of the work, such as cultivation of medicinal plants, nursery work (other than those which can be done under the climatic and edaphic conditions of Dehra Dun), taxonomical work on plants and insects and similar other investigations may, to a considerable extent, advantageously be distributed to such other Government institutions as the Royal Botanic Garden, Calcutta, Botanical Survey of India, Chinchona Cultivation in Bengal, Zoological Survey of India, and similar other institutions. By such a step the work on the applied aspect of investigation may better be concentrated at the headquarters. The work of some sections of investigations may also be carried on more efficiently, at least up to a certain stage, at the various provincial forest stations all over India with slight reorganisation and provision of a small nursery and laboratory attached to the forest office. Silvicultural, botanical (ecological) and chemical investigations, if done on the spot, will be more accurate. These results may conveniently be

co-ordinated at the centre and some congestion of work might thus be profitably removed. A little expansion and organisation in certain directions and to a certain extent team work in co-operation with some of the professors of the universities are likely to prove fruitful in tackling many a problem in both the pure and the applied aspects of investigations relating to the betterment of India's enormous forest wealth.

Announcements

THE New York Academy of Sciences announces three prizes offered by Mr A. Cressy Morrison to be known after his name, all of which will be awarded in December 1940. Prize I of 500 dollars will be

awarded for the best paper on solar and stellar energy, the competition being open to all. Prizes II and III will be awarded for the best papers on a scientific subject included within the field of the New York Academy of Sciences and its affiliated societies and are limited to members of the above bodies but non-members may become eligible by joining one of these organizations before the closing date.

DR S. K. Kulkarni Jatkar, D.Sc., F.I.I.Sc., F.I.C., F. Inst. P., was awarded the decree of doctor of science in chemistry of Bombay University at the recent convocation, for his thesis on Specific Heats of Organic Vapours from Supersonic Velocity. He is the second person to obtain the D.Sc. in chemistry from Bombay University, the first being Dr A. N. Yajnik of Lahore.

ANALYSIS OF SCIENTIFIC WORKERS IN THE U. S. A.

THERE were on November 1, 1939 a total of 41,912 civilian scientists in the employ of the Federal Government, each receiving an annual salary of at least \$2,000, of whom 40,200 were males and 1,712 were females. There were, in addition, 17,615 representatives of other professions, such as accountants, architects, lawyers and librarians.

Of the scientists, the engineers were the most numerous, with a total of 17,702. The next largest group was the economists, with 6,300 males and 300 females. The physicians and dentists stand high with 2,650, of whom only 50 are women, followed closely in numbers by 2,000 veterinarians. If the word *scientist* has been interpreted rather more liberally in the foregoing than is customary, we may note that there were on the list 3,200 agriculturalists and botanists, 1,230 physical scientists and geologists, 1,335 chemists and metallurgists, 780 statisticians and mathematicians, 640 zoologists and naturalists and 1,015 entomologists and husbandmen. One of the interesting groups is the 445 reporters and editors, or one for every 94 scientists, even with the liberal interpretation of the term used above.

F. R. M.

SCIENCE IN INDUSTRY

Stainless Steel Improved by Silver

STAINLESS steels show a tendency to pitting forming microscopic holes which deepen when subjected to corrosive action, especially due to brine. A remedy has been found recently after three and half years of research at the Massachusetts Institute of Technology. A small quantity like 0.25% of silver, when added in the alloy as nickel-silver, increases resistance to pitting, improves machinability, lessens hardening under drawing and spinning processes, increases thermal conductivity by some 25%, and gives better surface polish. Great care is required in producing the alloy, but once formed, it is quite stable and may be remelted and poured, without any material change. Castings, sheets, and rods are easily produced. This improved variety will be much used in the marine and refrigerating fields where saline solutions are encountered.

N. K. S. G.

Boiler Scales Removed Chemically

HEAT efficiency of boilers and other steam-generating equipments falls to a very low value due to the formation of scales inside them. Much of the tube failures and boiler explosions are also due to the same cause. Consequently the prevention of the formation of scale and its removal are major problems in power plants. Formation of scale is prevented by softening the feed-water by chemical means. But until now all the methods for the removal of scales formed were mechanical. There are however certain inherent disadvantages in the mechanical cleaning methods. The boiler parts are to be completely dismantled, even then all points inside a boiler are not accessible, and in addition, fresh scale deposition is hastened on metal surfaces not thoroughly cleaned.

A chemical solvent is expected to do away with these disadvantages and recently the methods of application of suitable solvents have been perfected. For the proper selection of the solvent the scale is first analysed by X-ray powder diffraction method to reveal the nature of its components. Only a few milligrammes of scale sample are required for this

analysis. The usual base for the majority of the industrial solvents for scale removal is an inhibited hydrochloric acid. To this base auxiliary chemicals, such as special inhibitors, catalysts, wetting agents, intensifiers, and reaction control agents, are added to facilitate results and to protect the exposed metal surfaces. Different scales require different inhibitors and auxiliary agents. Types of metals and treatment conditions also influence the selection of auxiliary chemicals.

Some scales are encountered which require special chlorinated solvents for complete removal, whereas others require organic solvents. While the same solvent is not effective on all types of scales, certain scales have been found for which no satisfactory solvent has been found yet. But if these insoluble constituents are present in small amounts, then the hinder can be dissolved away and the loose disintegrated scales can be washed away with water afterwards.

After a careful examination of the sample of scale to be removed, the metals to be encountered, and the design of the unit to be cleaned, the solvents best suited for this particular treatment is determined along with the temperature, time, and method of circulation.

N. K. S. G.

Fire-Retardant Paint

Extensive researches are being carried out at the United States Forest Products Laboratories to prepare paints which will protect wood against fire. Up to date linseed oil paints containing finely ground borax have been found to be most satisfactory. Paints containing white lead as pigment have given the best results, but those using titanium, or zinc sulphide pigments are also effective. Typical formulas for fire-retardant paints are :

PER CENT BY WEIGHT				
Pigment	Basic Carbonate (white lead) ...	Titanium- Calcium	30-0	Lithophone ...
Borax	... 41.0	35.0	30.0	24.0
Raw linseed oil	... 32.0	30.8	30.8	32.3
Turpentine	... 22.8	3.8	3.8	3.8
Japan drier	... 3.8	0.6	0.6	0.6

To secure maximum fire protection, at least one gallon per 125 sq. ft. (3 or 4 thick coats) are required. Although they will not protect wood effectively against continuous exposure to high temperature yet they are effective against spread of small fires. Moreover they are not satisfactory for exterior use because rain leaches out the soluble borax and the degree of fire retardance decreases with exposure. The paint gives a yellow tint but this tendency can probably be reduced by modifying the vehicle.

Such paints are yet in the developmental stage and much additional information will be needed to perfect them. Their use has been recommended only where resistance to fire is of greater importance than other properties.

N. K. S. G.

A New Type of Copper

AFTER ten years of strenuous research and expenditure of an enormous sum of money Phelps Dodge Copper Products Corp. of N. Y., U. S. A., has developed a new type of copper, which has been trademarked as PDCP, and is said to have greater conducting power, ductility, fatigue resistance, and surface qualities than ordinary copper.

One of the principal difficulties of the engineers and maintenance-men concerned with copper windings in motors and transformers is the existence of surface impurities in the copper, which are generally produced in the casting processes and by vibrations, due to which magnetic stress penetrates the insulation and causes failure by short circuits. Moreover silvers and oxides are more or less inherent in the hot-rolling processes. The new method has not only eliminated the casting process but also has improved the hot rolling process so that oxides and silvers are completely absent.

In the new method electrolytic cathode copper is plastically converted by tremendous pressures at a high temperature and in a reducing atmosphere into smooth dense, copper bars, rods, strips or other commercial products. Thus electrolytic copper, basically of the oxygen-free type, being not melted in the subsequent treatments, not only retains its original purity but further enhances it at the higher temperature and reducing atmosphere.

It has given outstanding performance in high-frequency and high voltage transformer windings, in high tension and submarine cables, in refrigeration and air-conditioning installations. It is particularly applicable for services where severe vibrations are encountered. Ductility being greater than ordinary

copper, with this new type sharper bends, easier forming and drawing are possible. The metal is said to approach the malleability of gold.

N. K. S. G.

New Treatment for Boiler Feed Water

DUE to high pressures and severe conditions met in modern power plants the problem of feed water treatment has become more complicated. Mere water-softening does not suffice, but the water should also be conditioned with respect to its alkalinity and dissolved oxygen etc. Many of the important water-treating chemicals are sulphur compounds. The principal coagulants, for instance, are all sulphates, as alum, copperas, and ferric sulphate. Sodium sulphite as is used for subsequent chemical de-aeration and sulphates are being used for many years to establish the proportional concentrations between sodium sulphate and alkalinity for the prevention of the caustic embrittlement. In order to prevent the zeolite minerals or to control the formation of deposits in the feed water systems, pH value of the water is to be lowered, for which either sulphuric acid or an acid sulphate is frequently used.

Mr. S. T. Powell has presented a novel idea (Sulphur Burners Applied to Feed Water Treatment, *Power Plant Engineering*, May, 1940, p. 54) of treating the feed water directly with sulphur dioxide. Despite its apparent complications, the method may prove feasible in certain types of large plants. Mr Powell is applying this new method at the Hoskins Mound Mine of the Freeport Sulphur Co., U. S. A. Sulphur burners for the purpose are of a somewhat special design and sulphur dioxide is introduced into the pre-softened feed water along with some catalyst to hasten oxidation. Normally 0.01 to 0.025 parts per million of copper as copper sulphate has been found sufficient as a good catalyst. Mixed with air sulphur dioxide reacts with iron to form either of the iron sulphate coagulants desired. Ferrous sulphate solutions are also oxidised to ferric sulphate with sulphur dioxide and air. In dilute solutions sulphur dioxide can replace sulphuric acid or acid sulphates for neutralising alkalinity and it also forms the alkaline sulphites useful for de-aeration.

According to the author there is substantial saving in the cost of the water-treating chemicals. An additional advantage of using sulphur dioxide instead of sodium sulphate and sodium sulphite is that there is practically no increase in the amount of dissolved solids in the water. This is particularly important in the operation of the high pressure boilers. When sulphur dioxide is used, there is practically no increase in the dissolved solids since each molecule of

sulphur dioxide liberates a molecule of carbon dioxide. On the other hand the use of sodium sulphate in the particular case added 650 lbs. of dissolved solids to each million gallon of water.

N. K. S. G.

Increasing the Uses of Lac

THE Annual Report for the year 1939-40 of the Indian Lac Research Institute has been just published. The chemical section of the Institute has made substantial progress in the different programmes of research. Besides the fundamental researches into the chemical and physical properties of lac and shellac, research results from commercial viewpoint show promising grounds for an indigenous plastic industry. The modification of shellac and shellac components by formaldehyde and urea has given rise to a resin which is a suitable material for moulding powders. The only defect is that the resin is not strictly thermo-hardening. It has also been found that melamine, obtained from calcium cyanamide, when mixed in place of urea and boiled produces a solution which on evaporation in vacuum yields a spongy mass to be broken into powder. The earlier defects of the moulding powder have now been removed and further work is expected to do away with brittleness. As the chemicals, formaldehyde and urea are imported from foreign countries, investigations are continuing with a view to develop moulding powders independent of foreign chemicals. The Institute has also designed two small-scale plants for the production of urea and formalin, which may be set up as adjuncts to a moulding powder factory. Casein, a milk product, which is also obtainable from vegetables like *karanja* oil cake has been combined with shellac, which resulting products are found to serve a large number of purposes for which plastic materials like bakelite are now used. Further, to prepare sheets and slabs for insulation and constructional purposes, dry coal tar has been compounded with shellac, and this reducing the quantities of formaldehyde and urea in the composition is expected to lower the cost of making. Ordinarily black colour is produced in this reaction. Suitable composition with fillers like wood flour, kaolin, paper pulp and jute fibres and chemicals like urea, tartaric acid etc., have been prepared for injection moulding and further improvements are under study, with a view towards gloss, heat-and water-resistance and the necessary fluidity for handling. Shellac injection moulding, as distinct from compression moulding, promises a great future in the production of electro-technical goods. Already the Institute has been able to produce by this method

electrical switches which can be sold much more cheaply than those made by compression moulding due to the higher rate of production and the simplicity in the manufacture of the powder. Two other uses are likely to be made of the lac, one as a varnish and the other as recording discs. For the latter purpose it is proposed to coat aluminium discs or cheaper still, paste boards with shellac containing a small proportion of urea. Lacquers are also being prepared by compounding with nitrocellulose in spirit with a small proportion of ester.

In the field of entomological research the most important development during the year has been the initiation of a large-scale field experiment to test the practicability of biological control, i.e., controlling of enemies of lac by their own insect enemies. Such control has in previous years been shown to be practicable under laboratory conditions.

The field experiment is at present only in its infancy, but results so far obtained show considerable promise. The Institute plantation has been fully utilised during the year and results obtained as regards the mortality and fertility of various strains of the lac insect have been recorded. Work has also been concentrated on two egg parasites of the major lac predators. These insects are being bred in the laboratory and indications, so far are that they are of great potential importance, in the control of these enemies of lac.

Vegetable Oils as Lubricants

A RECENT Bulletin of the industrial Research Bureau No. 18 indicates the amount of work that has been done to devise vegetable oil blends suitable for use as lubricants in internal combustion engines. The present issue covers the first part of the investigations and further work along these lines and the results of engine trials using stabilized vegetable oils will form the subject matter of separate papers. The important requirement of lubricants include chemical stability under working conditions, a high degree of 'oiliness' and a low co-efficient of static friction. Castor oil has been found to possess these qualities. Various patents have also been taken out in foreign countries dealing with processes for rendering castor oil soluble in mineral oil. The mixture has increased viscosity and lubricating power. During use however the high temperature causes oxidation of the lubricating oils which later deteriorates the quality and produces gum, carbon, sludge and acidic compounds. Mineral oils are made somewhat resistant to these destructive processes by refining, which removes asphaltic and unsaturated components, and then by adding certain anti-oxidants. But investigations

with vegetable oils, which have been carried out so far, have not used refined oils. The present work has therefore started with refined oils and is devoted to remedy the defects not likely to be vitiated by some of the undesirable components of the oil. Work has been done on three Indian varieties of oils *viz.*, castor, groundnut and cottonseed oil. In course of work on the methods of stabilization against oxidation of oils the present refining processes have been followed. In the laboratory tests, change in viscosity, acid value and Conradson carbon residue were determined before and after oxidation according to British Air Ministry technique with modifications for acceleration of the processes. It appears that the extent of the unsaturation of a given oil and its acidic constituents determine whether or not it may be effectively stabilized. The exact mechanism of the stabilizing action is still obscure, although phenolic and amino groups coupled with more than one benzene nucleus have been found to exert a stronger stabilizing action than compounds characterised by other groups.

Fibre Resources of Bombay

A PRELIMINARY survey of the fibre resources of Bombay province has been carried out by Mr J. K. Sircar, Fibre Expert of the Department of Industries, in pursuance of the scheme for the development of the fibre industry. The survey in the important fibre plant-growing districts of Ratnagiri, Belgaum, Ahmednagar, Thana, Poona and Nasik showed that existing plants useful for commercial and industrial utilisation are Sann hemp, Deccan hemp or "Ambadi", aloe fibre or sisal plant, linseed crops and "Kittul" fibre.

Sann hemp or "tag" is the most important fibre crop in the Province. During the war of 1914-18, when the flax and hemp supply from Russia was stopped, Britain imported Sann hemp from India in considerable quantities to use with the European soft hemp in the production of twines, ropes, canvas and other articles. This assisted considerably the export trade in Indian Sann hemp, specially the famous "Dewguddy" or "Devgad" type, which is produced in this province. The manufacture of fabrics, other than canvas, from hemp of Ratnagiri quality, which is generally more costly than jute, would not however prove profitable. If additional experimental chemical treatment and spinning tests prove successful, it would be possible to introduce a factory-scale industry to produce finer twines and canvas. The quantity of hemp manufactures imported for 1936-37 into Bombay was valued at Rs. 3,30,710 for pack-thread, cheap bazar twine, fishing twine, etc. The manufacture of these twines can be carried out in cottages with proper organisa-

tion. As people have no knowledge of the industry, the Bombay Government have recently sanctioned a peripatetic demonstration party to train villagers in twine-making.

Ambadi hemp is another major fibre crop of the province, but there is practically no trade in this fibre. Experiments with the existing quality of fibre have shown that, if it can be grown and retted properly, it could be utilised for the manufacture of gunny-bagging, set-sacking for carrying raw-cotton, carpets and unsized twine.

Regarding sisal hemp, experimental work has shown that commercial and profitable utilisation of existing Agave leaves on improved lines would play an important part in the rural economy of the countryside. This can be done by training the villagers in improved methods of extraction of fibre and the manufacture of commercial commodities. Further an investigation into the collection and marketing of "Kittul" fibre is expected to prove of benefit to villagers and helpful to brush manufacturers.

Marketing of Eggs in India

THE importance of poultry keeping in India and Burma is indicated by figures given in the latest of the Marketing Series, which takes the form of an abridged report on the marketing of eggs in India and Burma. The report states that India produces every year about 33,648,00,000 eggs and Burma about 1,636,00,000. The total value of the eggs sold in the course of the year amounts to Rs. 5,25,00,000. The value of the birds themselves is equal to approximately Rs. 7,50,00,000. In the course of marketing the loss due to 'staling' of eggs, breakages, etc., amounts, at some periods of the year, to as much as 25 per cent, and the total loss to industry from various causes is estimated by the report at over Rs. 57,00,000 a year. As an instance of wastage which occurs, the report states that losses in grading eggs due to the present haphazard methods of keeping poultry are estimated at Rs. 14,00,000 a year; breakages in the course of collection, transport and distribution are estimated at Rs. 15,00,000 a year, and staling in the course of marketing is estimated to cost Rs. 28,00,000 a year.

In order to eliminate this wastage the provision of better housing and nesting, improved containers, more rapid and systematic collection of eggs and the provision of insulated and refrigerated transport facilities and more cold stores at rail-head in the larger consuming centres are stressed in the report. Apart from eliminating over Rs. 50,00,000 worth of loss due to wastage, experience has shown that proper

"Agmark" grading and marking of eggs brings in enhanced returns to the extent of 15 to 20 per cent. As there are, at least, 150 centres already in existence where anything up to 50,000 eggs are assembled

daily, the rapid expansion of organised grading and marking stations would easily and readily be done by local marketing staffs and co-operative departments with much profit to poultry keepers.

India's Industrial Waste : Fusel Oil

S. DUTT

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FUSEL oil is a product of the fermentation of saccharine materials by yeast during manufacture of wines and spirits. It is formed in minute quantities and is the substance mainly responsible for the characteristic smell and taste of spirituous liquors. Most of the wines and spirits that are in the market nowadays contain from 2 to about 800 parts of fusel oil per 100,000 parts of the material, and some of the illicit drinks prepared in country stills may contain much more than this proportion. Fusel oil is a recognised poison to the human system, and most of the ill effects of drinking alcoholic liquors have been attributed to the insidious poisoning by fusel oil contained in them. Hence many of the manufacturers of wines and of spirits, particularly the latter, try to remove much of the fusel oil from their products by fractional distillation or by chemical means, and the maturing of wines and spirits by aging in wooden casks or barrels is really intended to remove as much of the fusel oil as possible by a process of absorption. The following table will give an idea of the proportion of fusel oil present in various wines and spirits :

TABLE I. FUSEL OIL IN WINES AND SPIRITS.

Name of the wine or spirit				Parts of fusel oil in 100,000 parts of the spirit or wine.	
1.	Beer	...	...	1.7—	3
2.	Sherry	...	...	3 —	5
3.	Madeira	...	...	5 —	7
4.	Port	...	...	8 —	10
5.	Cider	...	...	3 —	5
6.	Claret	...	...	3 —	5
7.	White wine	...	...	2 —	4
8.	Red wine	...	...	4 —	6
9.	Gin	...	...	35 —	40
10.	Jamaica rum	...	...	95 —	108
11.	Dewar whisky (5 years)	...	...	189 —	224
12.	House of Lords whisky (10 years)	...	...	217 —	265
13.	Hennessey brandy (2 years)	...	...	253	
14.	Martel brandy (10 years)	...	...	354	
15.	Bourbone whisky (new)	...	...	668	
16.	Country spirits (35 U.P.) Pot Still	...	...	923 —	1254

The removal of fusel oil from spirits by fractional distillation is known as rectification, and the pure spirit thus obtained is known as "rectified spirit". But even the most highly rectified spirit contains 2-3 parts of fusel oil in 100,000 parts of the spirit, for all ordinary purposes, however, this is a negligible quantity. The rectification of wines or fermented liquors for the production of rectified spirit is carried out in a large distillation apparatus patented by Coffey in 1831, and which is on that account known as "Patent Still". In that apparatus which is divided into two parts known respectively as the 'analyser' and the 'rectifier', almost complete separation of the alcohol from the water and the fusel oil takes place, and the fusel oil being insoluble in water, now begins to float on the surface of the wash water as an oily layer with a strong characteristic odour. It can therefore be easily separated from the water and collected. But in India although there are quite a number of factories manufacturing rectified spirit from fermented molasses, yet in the vast majority of them, the fusel oil is never separated or collected. It is allowed to go to the drain with the waste water, and therefore a valuable industrial material is lost. India is a country of colossal wastes, and the loss of fusel oil in the alcohol factories in India is an example of these. For every 1000 gallons of rectified spirit produced, 3-5 gallons of fusel oil are also produced simultaneously, and if this is recovered and utilised as indicated furtheron, it may constitute an important source of national wealth. The present author has already indicated in a separate article* that India now produces in her sugar factories, over 200,000 tons of molasses, which when fermented and converted into rectified spirit can yield enough fuel to meet most of the motoring needs of India. Simultaneously there will also be produced

* "Rectified spirit as motor fuel" in *SCIENCE AND CULTURE*, 5, 698, 1940.

nearly 50000 gallons (i.e., approximately 230 tons) of fusel oil which can easily satisfy all the present technical and industrial demands for this material. On account of the large number of uses that have already been found for fusel oil and its derivatives, it is high time that the large-scale recovery and utilisation of fusel oil be started in India now, so as not only to partially prevent the flow of national wealth to foreign countries, but also to make use of a wealth that is literally going to the drains.

Fusel oil is a bright yellow oily liquid with a specific gravity of 0.83 to 0.85 and an intense and nauseating odour of old whisky or rum. It is insoluble in water, but easily soluble in 70 per cent alcohol. It dissolves waxes, resins and oils of various description, and on that account is often used in the preparation of furniture polishes, leather dressings, paints, varnishes and enamels, but its most important use consists in the preparation of butyl and amyl alcohols and their acetic esters, which are commonly used as industrial solvents.

The compositions of fusel oils differ very considerably from one another according to the source from which they are obtained and also according to the conditions of the fermentation. The following are recorded analyses in literature of fusel oils from: (i) beet, (ii) grapes, (iii) barley, (iv) potato and (v) maize:

TABLE II. ANALYSES OF FUSEL OILS.

(Figures indicate percentage of various components).

Components	Beet	Grapes	Barley	Potato	Maize
Ethyl alcohol	5.8	6.2	5.0	7.5	4.8
Acetaldehyde					
Acetal					
Water	8.2	9.5	6.5	12.5	6.0
Isopropyl alcohol	...	...	...	15.0	...
n-propyl alcohol	13.0	13.2	31.6	3.0	3.6
Isobutyl alcohol	12.4	6.5	5.0	24.3	15.7
n-butyl alcohol	6.2	7.5	5.2	3.5	7.5
Isoamyl alcohol	51.5	53.2	42.3	27.5	57.3
n-hexyl alcohol	0.3	0.3	0.8	...	1.2
n-heptyl alcohol	trace	trace	trace	trace	trace
Free fatty acids	0.1	0.1	0.16	0.1	trace
Fatty acid esters	0.2	0.1	0.2	0.2	0.3
Surfactant and bases	trace	trace	trace	trace	trace
Terpenes	...	...	...	0.3	...

There has been no authentic record of the complete analysis of molasses fusel oil in literature, but the present author has carried out the following analyses of four samples of Indian molasses fusel

oils collected from distilleries situated in different parts of India:

TABLE III. ANALYSES OF INDIAN MOLASSES FUSEL OILS.

(Figures indicate percentages of various components)

Components	From Roan Distillery, Shahjehanpur (U.P.)	From Cawnpore Distillery (U.P.)	From Murree Brewery Co. Rawalpindi (Punjab)	From Mandya Distillery (Mysore)
Ethyl alcohol	1.2	5.57	0.55	trace
Butyric aldehyde	...	...	6.2	...
Isopropyl alcohol	17.6	2.2	2.1	18.4
n-Propyl alcohol	3.2	0.23	0.08	0.49
Water	5.7	5.1	6.0	5.1
Acetal	1.6	0.12	0.04	0.16
Isobutyl alcohol	1.8	0.22	0.02	0.16
Ethyl isobutyrate	0.7	0.16	0.04	0.18
n-Butyl alcohol	5.0	0.37	0.06	0.34
Isoamyl alcohol	60.9	85.2	72.9	66.2
n-Amyl alcohol	...	0.1	0.08	0.71
Ethyl valerianate	trace	0.03	0.02	0.02
n-Hexyl alcohol	0.2	0.04	0.08	0.07
n-Heptyl alcohol	0.2	0.52	0.03	0.32
n-Octyl alcohol	0.7	0.52	0.05	0.51
n-Nonyl alcohol	...	0.02	0.24	0.06
Higher esters	trace	3.2	2.1	2.3

From the above figures of analyses, it can be easily seen that there are two important constituents in Indian Patent Still molasses fusel oils which are present in large quantities, namely isopropyl alcohol and isoamyl alcohol. Both these substances can be easily recovered from molasses fusel oils by a process of fractional distillation. The following are the chief chemical and physical properties of these useful substances:

Isopropyl Alcohol—It is a colourless highly inflammable liquid with an agreeable spirituous smell and a specific gravity of 0.789 at 20°C. It is miscible with water in all proportions. It boils at 83°C, and has a high dissolving power for waxes and resins. It also dissolves to a fair extent the lower nitrates and acetates of cellulose. This together with its great volatility, makes it an excellent solvent for spray varnishes and enamels and also for shoe and furniture polishes, but unfortunately its comparative rarity and high price up till now have prevented its common use for these purposes. In case it is manufactured from molasses fusel oils in India, it can be easily made available for these purposes for which it is admirably suited. When oxidised, it is converted into acetone, which is another very important industrial solvent, indispensable for celluloid and explosive manufactures.

Isoamyl Alcohol—It is a colourless oily liquid, insoluble in water and boiling at 129-31°C. It is inflammable and has a peculiar and characteristic

empyreumatic smell, which is somewhat in disfavour of this otherwise excellent organic solvent. It has a specific gravity of 0.81 at 20°C. It is an excellent solvent for a wide variety of gums and resins and also waxes of various descriptions, and is on that account used in the manufacture of paints, varnishes, polishes and enamels. But the introduction of its acetic ester as an industrial solvent, has put amyl alcohol in the background on account of the fact that amyl acetate has a much more powerful solvent action than amyl alcohol. Besides that, amyl acetate dissolves many important synthetic plastics like pyroxylin, celluloid, xylonite and acetyl cellulose, on which amyl alcohol has hardly any action. As an additional advantage, amyl acetate has a pleasant banana-like smell as contrasted with the nauseating empyreumatic smell of amyl alcohol. On account of these interesting properties, amyl acetate is now a very important industrial solvent, and so a description of its method of preparation and properties would be quite appropriate before the conclusion of this article.

Amyl Acetate—On an industrial scale this compound, which is technically speaking the acetic ester of amyl alcohol, is manufactured by heating a mixture of amyl alcohol and glacial acetic acid with concentrated sulphuric acid or anhydrous calcium chloride. In actual practice, 20 kilos of amyl alcohol, 50 kilos of glacial acetic acid and 10 kilos of concentrated sulphuric acid or 18 kilos of anhydrous calcium chloride are heated together under a reflux condenser for 6 or 8 hours. With sulphuric acid the yield of amyl acetate is 20 kilos, and with calcium chloride, 25 kilos. The ester is washed with water, dried and purified by fractional distillation. On account of the greater cost of calcium chloride, sulphuric acid is generally used as the condensing agent, in spite of the diminished yield of the ester. The pre-war price of amyl acetate in India at ports was about Rs. 2/8/- per pound, but now the price has gone up considerably and it is only available with difficulty.

Amyl acetate is a colourless oily liquid, insoluble in water, with a very pleasant fruity smell resembling banana. It boils at 137-38°C and has a specific

gravity of 0.872 at 25°C. In small quantities it is used in syrups, *sherbets*, aerated drinks, toffees, lozenges, jellies etc., as a banana essence. But its most important use nowadays is in the manufacture of nitro-cellulose paints and varnishes of the type of Duco, Dope, Nitro-valspar etc. It has a high dissolving power for celluloid and is extensively used in that industry and also in the preparation of celluloid varnishes like Glazo, Plastico, Cutex etc. It is also used in the manufacture of a special kind of artificial silk or rayon known as Celanese, and is also employed to an increasing extent in the explosive industry as a partial substitute for acetone in the manufacture of cordite. Amyl acetate is one of the most important industrial solvents of the present day, and any country possessing the necessary raw materials for its manufacture is likely to be at an advantage in the commercial world.

Fortunately India is in a very good position for the manufacture of amyl acetate. If all her molasses resources are converted into alcohol, there will be available in this country nearly 50000 gallons of fusel oil, from which about 6000 gallons of amyl acetate, valued at Rs. 16 lakhs can be easily prepared, which will not only satisfy the present need of India for this important material, but will also leave a substantial surplus for export. In the present stage of industrial development of India, she can hardly afford to overlook this important source of national wealth.

It will be interesting to note in this connection that the present author, who first started the chemical examination and analysis of Indian molasses fusel oils, has recently discovered a very interesting reaction by which the amyl alcohol contained in the Indian fusel oils can be quantitatively converted into amyl acetate with the help of a catalyst which is recovered unchanged at the end of the reaction. When applied on an industrial scale, this reaction will revolutionise the method of manufacture of amyl acetate and make it very easily and cheaply available to Indian manufacturers who are in need of that substance. This reaction or process is being made the subject of a patent by Allahabad University.

MEDICINE & PUBLIC HEALTH

Central Advisory Board of Health

At a recent meeting of the Central Advisory Board of Health, consisting of the representatives of the central and provincial governments and of the governments of certain Indian States, reports of two special committees appointed to investigate the possibility of introducing compulsory inoculation of pilgrims against cholera and to study the complex questions associated with the prevention of food adulteration in India were considered, besides the questions of providing free laboratory service for diagnosis of infectious diseases, upkeep of the health of school children and of the lack of enforcement of bye-laws from hygienic view-point by the local bodies in the matter of building houses. The Board recommended that provincial governments should select suitable centres in their areas and try out a scheme of indirect compulsory inoculation on lines successfully pursued by the Government of Bombay for the past four years in connection with the Pandharpur festival. The committee on food adulteration has so far considered only the technical aspect of the problem, including food standards and technique of food analysis, and it is expected that its reports on the legislative and administrative aspects will be made available for the Board at its next meeting. The committee emphasised the fact that the improvement of methods of food analysis and the prevention of food adulteration in India will have to be a continuous process and that the establishment of co-ordination between the provinces is a matter second to none in urgency. With this object in view the Board recommended the appointment of a standing committee to be called "The Central Committee for Food Standards" which would be in a position to advise the central, provincial and State governments on all aspects of food adulteration. All-India standards for 17 articles of food, have already been recommended and the standards for other articles will be investigated by the proposed Central Committee for Food Standards. The Central Committee would issue "instructions" incorporating the latest available information regarding methods of analysis for the use of the public analysts. The standardisation of methods is

as important as the unification of standards of food purity.

The provision of a free laboratory service to medical practitioners is essential for a successful campaign against typhoid and many other infectious diseases. The value of such provision was demonstrated in Bombay during an epidemic of typhoid fever in 1938 when the Government of Bombay placed the services of the Haffkine Institute at the disposal of the medical practitioners of the city. The Board recommended a scheme for starting a provincial laboratory service which outlined a system of small district laboratories supported by regional laboratories for groups of districts and by a central laboratory for the province, which would co-ordinate the activities of the regional and district laboratories.

Vitamin C and Gold Therapy in Arthritis

NOWADAYS gold preparations are extensively used in the treatment of tuberculosis and joint diseases. Troublesome complications often met with in course of the gold therapy are diminution in the number of red blood cells and redness of the skin associated with some eruptions. These complications are considered to be due to poisoning of the body with the metal. Secher (*Lancet*, i, 735, 1940) determined the ascorbic acid content of the blood of these patients and no blood ascorbic acid was obtained in these cases. He therefore administered vitamin C to some of his patients suffering from arthritis along with sanocrysin (a gold preparation) injections. All the complications subsided and blood ascorbic acid rose to the normal level. He therefore suggests that the reactions or complications often met with after injections of gold preparations are due to the liberation of toxins from the site of infection and not due to the metal itself. When vitamin C is administered in increased amounts, it combines with or neutralises the toxins liberated after gold therapy and thereby prevents the resulting complications. He advocates vitamin C therapy before and during treatment with gold preparations.

S. B.

Sulphathiazole in Bubonic Plague

SULPHATHIAZOLE, a heterocyclic derivative of sulphanilamide, has been found to be superior to sulphapyridine in the treatment of bubonic plague in the hands of Sokhey and Dikshit (*Lancet*, i, 1040, 1940). They have cured 80% of plague-infected mice by injecting within twenty four hours of infection, 10 mg. of sulphathiazole, twice a day, for ten days. If the treatment is commenced within forty-eight to seventy-two hours after infection, a higher dose of 4 mg. twice a day for ten days is necessary to cure 80—90% of infected mice.

S. B.

Vitamin P and Purpura Haemorrhagica

JERSLID (*Lancet*, i, 1445, 1938) successfully treated cases of Henoch's purpura with vitamin P. Scarborough and Stewart (*Lancet*, ii, 610, 1938) treated two cases of purpura haemorrhagica, developed after arsenic therapy, with the vitamin. Recently Gorrie (*Lancet*, i, 1005, 1940) cured a similar case of purpura haemorrhagica with vitamin P. There was no deficiency of vitamin C in this case.

S. B.

Radium and Radon

RUSS and Scott (*Lancet*, i, 1048, 1940) compared the biological reactions of radium and radon on the rabbit's ovary. Similar effects were produced in each case. Radon is more easily available than radium, and in the place of radium therefore radon may be used with advantage in the treatment of cancer, tumours, and of skin and other diseases which are now subjected to radium therapy.

S. B.

Decurvon

BRAIN (*Lancet*, i, 1078, 1940) has described a preparation of insulin, Decurvon, in which a highly purified pectin, consisting of an ester of galacturonic acid, has been added to insulin. The action of this preparation of insulin is much more prolonged than that of ordinary insulin. The injection of this preparation is absolutely painless. No reactions are met with as are often obtained with zinc-insulin preparations and unlike the latter it can be injected intravenously in cases of diabetic coma.

S. B.

Use of Hypertonic Solution of Sucrose in the Treatment of Hypertension

FOR the reduction of increased intracranial pressure 20 to 25 per cent., solution of sucrose is being frequently used nowadays. Bullock *et al* (*Amer. Jour. Physiol.*, 112, 82, 1935), Masserman *et al* (*Bull. Johns Hopkins Hosp.*, 57, 12, 1935) and Jackson *et al* (*Ann. Surg.*, 106, 161, 1937) obtained beautiful results after the intravenous administration of hypertonic solution of sucrose. The sugar was excreted by the kidneys and there was profuse diuresis. No serious toxic effects were obtained. Helmholtz (*Jour. Pediat.*, 3, 144, 1933), however, observed that hypertonic sucrose given intravenously to rabbits produced swelling and degenerative changes in the renal convoluted tubules. This observation of Helmholtz was confirmed by Lindberg *et al* (*Arch. Int. Med.*, 63, 907, 1939) in dogs. Anderson *et al* (*Jour. Amer. Med. Assoc.*, 114, 1983, 1940) observed similar pathological changes in the renal tubules in six patients after post-mortem examination. These patients received intravenous injections of hypertonic solutions of sucrose. Hypertonic sucrose therefore should not be used in cases of hypertension.

S. B.

Indian Ephedra Research Creates Demand

ACCORDING to investigations carried out in the Forest Research Institute, Dehra Dun, the active principle in the Indian ephedra is in no way inferior to the Chinese ephedra, which till lately constituted the chief source of supply of this drug. This drug is a potent remedy for asthma and hay fever. Indian ephedra is now being exported to the United Kingdom, but till 1938, export to the United States of America was almost negligible. In 1937, China exported ephedra to the extent of over two million lbs., of which the United States of America alone took 1,196,000 lbs. But in 1938, when supplies from China and Spain were reduced by wars in those countries, India exported to the United States of America 446,300 lbs. of the drug worth about Rs. 88,000/-. If Indian ephedra is to establish herself in the American market—for which this is the right time—there must be a regular supply of the drug of uniformly high quality. This can only be ensured if the right species of the plant are collected from suitable localities and at the proper season. Failure to attend to these essentials in the past stood in the way of India's getting a permanent foothold for her produce in the world markets.

Delhi Urban Housing Scheme

A DEVELOPMENT of considerable importance is in progress in regard to housing conditions in the old city of Delhi. The principle has been accepted by Government that assistance should be given to persons dispossessed by slum clearance schemes to enable them to obtain not only alternative accommodation but also accommodation of suitable standard from the hygienic point of view. The minimum rent for houses fit for human habitation was assessed by the Delhi Improvement Trust at Rs. 5/- per month and the lowest income which could afford to pay this rent at Rs. 30/- per month. It has been accepted that a family with an income less than this amount cannot pay for a house fit for human habitation and that it, therefore, needs assistance for rehousing. Three types of houses have been proposed, one-roomed, two-roomed, and three-roomed. Not more than three adults (counting two children as one adult) are to be permitted to live in a single roomed house and not more than five adults in two-

roomed houses, while larger families would be permitted to live only in three-roomed houses. Standard plans have been prepared for these types of houses, the approximate cost of which will be Rs. 450/-, Rs. 600/- and Rs. 750/- according to class.

The experiment proposed in Delhi will make it possible for the poor class families to own their own houses on the hire purchase system. The average capacity for rent of the families to be dispossessed is estimated at Rs. 2-13-0 per month while a return of Rs. 5-3-6 per month is stated to be necessary to meet the total cost on a non-profit basis, including the charges for equated instalment payments over a period of 20 years. Any dispossessed family which can pay the rent of Rs. 3-8-0 per month will be admitted to the benefit of ownership through the hire purchase system, the difference between this amount and the minimum rent for covering the cost of the scheme as indicated above, being met by grants from the proceeds of a special entertainment tax imposed by the Government.

Carotinoids and their Biological Importance

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CAROTINOIDS is the name given to a group of yellow to orange and red pigments which are very widely distributed in nature. They occur in all forms of living organisms ranging from the lowest bacteria to the highest forms of plant life. In the animal kingdom they are also present from the lowest to the highest animals, from protozoa to man. The name carotinoid is derived from one of the pigments of this class "carotin", so-called because it was obtained from carrots (*Daucus carota*), which was the first pigment of this class to be isolated in crystalline form. Carotene has not only lent its name, but has proved to be the most important pigment of this group.

Carotene was first described by Wachenroder (1826), who called it carotin. Arnaud (1886) proved the hydrocarbon nature of the pigment and it was Willstätter and Mieg (1907) who definitely settled the composition as $C_{40}H_{56}$, described its properties, its

unsaturated nature, and developed methods of isolation and purification.

Willstätter's work gave a lot of stimulus to the study of the carotinoid pigments. It was discovered that these pigments were most universally present. They were present in all sorts of locations and under all sorts of circumstances. For example, besides carrots they were present in a number of other roots, in the chloroplastids, in the tissues of chlorophyllaceous plants, in leaves, particularly in all green leaves, in etiolated leaves, in naturally yellow leaves, in yellow autumn leaves, in the autumn and winter reddening of plant tissues, in flowers, in fruits, in seeds and grains, in a large number of red and green algae, in fungi, in brown and red seaweeds, in bacteria, in diatoms, in moulds, and yeasts, in the corpus luteum of mammals, in the blood serum, in the milk fat, in adipose tissue, internal organs, skin, nerves, in egg yolk, in the retina of the eye, in feathers of birds and in tissues of fishes, amphibians,

reptiles, insects, crustaceans, echinoderms, molluscs, worms and sponges etc. These are just some of the tissues quoted by way of example from which these pigments were isolated and studied. This universal occurrence of carotinoids in both plant and animal tissues raised the question, "Have they any function to fulfil?". In plants they should have a function since the plants synthesize them and they are almost always associated with active metabolism. The understanding of the functions of the carotinoids in the plants, however, has not progressed beyond the domain of conjecture. Without considering the various hypotheses advanced, let me at once proceed to the most interesting question, whether the carotinoids have any function in the life-process of animals.

Palmer was the strongest exponent of the view that carotinoids in the animals have no function at all. They are simply there by accident since they are so abundantly present in the food and they are there until the organism is able to excrete them or dispose of them in a suitable manner. On the other hand, some investigators were not inclined to the view put forward so strongly by Palmer. They considered that occurrence of carotinoids in tissues, of vital importance to the organism and in concentrations which bore no comparison to the rest of the body, offered a strong presumption that they were required there for some specific purpose. Take for example, the corpus luteum, or the yolk of an egg. Drummond, and Coward in a number of earlier papers dealing with vitamin A pointed out this phenomenon. The occurrence of carotene in a greater concentration in clostrum than later milk might mean that it was required for the new-born calf.

The controversy between Palmer and Steenbock is too well known to be recounted in any detail. Steenbock (1919) put forward the suggestion that vitamin A activity was associated with yellow colour in most plant materials. During the course of three years that followed, Steenbock and collaborators published a series of papers showing a close relationship between vitamin A activity and the yellow colour of several roots, *e.g.*, yellow corn *vs.* white corn, green loaves *vs.* etiolated leaves, green peas *vs.* yellow peas and so on. And later in 1920 Steenbock and collaborators made a definite statement that carotene with a constant m.p. could induce growth in rats on vitamin A-deficient diets.

Palmer, who very strongly refuted the contention of Steenbock, stated that the mere fact that carotinoids are of wide spread occurrence is no evidence of the fact that they must play a role in metabolism. The more sensible view to take was that they are

mere casual products in the animal organism derived from their food of plant origin. Palmer brought forward substantial evidence to prove his argument:

- (i) Carotinoids are not present in the tissues of all animals *e.g.*, sheep, goat and swine. The cow can exclude xanthophyll and the hen carotene from its tissues. This meant that these animals have the power to destroy one or the other of the carotinoids more efficiently. If carotinoids had any function, they would be of general occurrence and would always be present in the tissues. This is not the case.
- (ii) Even in such animals in which carotinoids naturally occur, they had no function because it could be experimentally shown that fowls could be raised from hatching to maturity on rations devoid of carotinoids. These fowls grew normally, lived healthily, showed normal fecundity and power of reproduction, produced eggs with white, carotinoid-free egg yolk and from those eggs normal chickens hatched.
- (iii) Albino rats grew and reproduced normally on almost carotinoid-free Ewe milk fat and carotinoid-free egg yolk.

Such was the strong and convincing evidence brought forward by Palmer that for a time Palmer's view-point seemed to have triumphed.

Eight years later in 1928 Euler, Euler and Hellstrom again reopened the question and definitely stated that pure carotene was active as a source of vitamin A. They explained that the failure of the earlier tests was due to the fact that these diets were deficient in vitamin D. Vitamin D was then not differentiated from Vitamin A. Very soon this observation was confirmed in other laboratories.

After it was proved that carotinoid pigments were of biological importance there was added interest and activity in this field. During the years following the work of Willstätter and his school there had been little work undertaken in this field. But now the organic chemist with his modern equipment attacked the problem and in course of a few years tremendous advance was made. Many new carotinoids were discovered and the whole chemistry, structure and formulae of the more important carotinoids were established. Credit for these outstanding discoveries rests mainly with Professor Paul Karrer and his school at Zurich and Professor Richard Kuhn and his colleagues at Heidelberg. A brief outline of the more important features of this study is presented in the form of a table. (Table 1).

TABLE I.

Group.	Name.	Formula.	Double bonds.	Oxygen linkages.	Physical constants.	Remarks.
I. Hydrocarbons	Carotene	$C_{40}H_{56}$	11	—	—	Discovered by Wachenroder (1826); Formula settled by Willstätter and Meig (1907); Structure worked out by Karrer (1931).
	1. " α	"	11	—	M.P. 172°C. Optically active. More soluble than β	Isomeric forms shown by Kuhn <i>et al</i> ; Karrer <i>et al</i> ; and Rosenheim and Starling in 1931; Formula worked out by Karrer and colleagues.
	2. " β	"	11	—	M.P. 182°C. Optically inactive, less soluble than α .	Structural Formula worked out by Karrer (1932). α & β can be separated by fractional crystallisation or fractional adsorption on fibrous clay or Fuller's earth.
	3. " γ	"	12	—		Discovered by Winterstein and Ehrenberg (1932); carot pigments contain 1% of it. Marsh-dodder contains large amounts. Structure by Kuhn and Brockman.
	"	—	—	—		Discovered by Winterstein (1933).
	4. Lycopene	$C_{40}H_{54}$	13	—		The red pigment of tomato contain conifers and red pepper. Existence in flowers shown by Zechmeister. Structure worked out by Kerrer.
II. Alcohols	5. Xanthophyll Lutein	$C_{40}H_{56}O_2$	11	2 OH	M.P. 192-193°C. [α] _D ¹⁸ = +138-152°	Formula settled by Willstätter and Meig (1907); Tswett postulated 4 xanthophylls. α , α' , α'' , β . Kuhn got only a single one. However isomers likely. It is derived from optically active carotene, i.e., α -carotene.
	6. Zea-xanthin	"	11	2 OH	(Optically inactive?) Now found it is active when obtained from leaves. [α] _D ¹⁸ _{CHCl₃} = -41°	Pigment of yellow corn. Isomer of xanthophyll, discovered by Karrer. Lutein of egg yolk is 30% zeaxanthin, 70% xanthophyll. This is derived from inactive β carotene.
	7. Krypto-xanthin	$C_{40}H_{56}O$	11	1 OH	Optically inactive.	Discovered by Kuhn and Grundman. Present in yellow corn with zeaxanthin. The pigment in papaya is mainly krypto-xanthin. The biological activity of yellow corn is due to this.
	8. Rubi-xanthin	"	12	1 OH	"	Discovered by Kuhn and Grundman, xanthophyll derivative of γ -carotene. Formula and structure shown by Kuhn.

TABLE I—Continued.

Group.	Name.	Formula.	Double bonds.	Oxygen linkages.	Physical constants.	Remarks.
	9. Flavo-xanthin	$C_{40}H_{56}O_2$	11	3 OH	M.P. 184°C [a] _D ¹⁸ = 190° C_6H_5	Isolated by Kuhn and Brockman (1932). This pigment yields intense blue colour with 25% HCl.
	10. Viola-xanthin	$C_{40}H_{56}O_4$	10	3-4 OH	M.P. 207-208°C [a] _D ²⁰ = +35° CHCl ₃	Discovered by Kuhn and Winterstein from pansies. Forms addition compounds of a salt type with intense blue colour.
	11. Tara-xanthin	$C_{40}H_{56}O_4$	—	4 OH	M.P. 184-185°C. [a] _D ²⁰ = +200°	Discovered by Kuhn and Lederer from dandelion flowers. Does not form salt with dilute acids and can be thus distinguished from viola-xanthin.
	12. Fuco-xanthin	$C_{40}H_{56}O_4$	10	4 OH	[a] _D ¹⁸ = +72° CHCl ₃	Pigment of the brown seeds. Formula settled by Willstätter and Meig (1914), and confirmed by Karrer and shown to be derivative of carotene.
	"	$C_{40}H_{56}O_4$	11	4 OH 2 CO	M.P. 166-8°C. Optically inactive according to Helibron.	Helibron and Peiper show recently that the formula is $C_{40}H_{56}O_4$. Structural formula presented based on insufficient evidence.
III. Ketones.	13. Rhodo-xanthin	$C_{40}H_{56}O_2$	12	2 CO		A diketone. It readily gives a dihydro-derivative. Discovered by Kuhn and Brockmann. It has been changed to zea-xanthin by Karrer by hydrogenation.
	14. Capsanthin	$C_{40}H_{56}O_2$	10	2 OH 1 CO	M.P. 175-176°C	Pigment of Paprika. Often occurs in ester form with oleic, palmitic, myristic, stearic acids, etc.
	15. Capsorubin	$C_{40}H_{56}O_4$	9	2 OH 2 CO		Closely associated with capsanthin in nature. Formula worked out by Zechmeister and Cholonok.
	16. Astacin	$C_{40}H_{56}O_4$	—	4 CO		Kuhn isolated it from eggs of sea spiders, and Karrer from star fish. Also occurs in the shells, eggs and epidermis of lobster.
IV. Acids	17. Azafrin	$C_{27}H_{34}O_4$	7	2 OH 1 COOH		First isolated by Lieberman (1911-15). Kuhn isolated it later and proposed the formula.
	18. Bixin	$C_{25}H_{30}O_4$	9	1 COOH 1 C ^O 1 C ^O CH ₃		Formula definitely established by Karrer by synthesis.
	19. Crocetin	$C_{28}H_{34}O_4$	7	2 COOH		Pigment of saffron. Formula definitely established by Karrer.

BIOLOGICAL IMPORTANCE OF CAROTINOIDS

After it was definitely established that carotene can act as vitamin A, it was soon discovered that vitamin A is formed by the breakdown of the carotene molecule in the animal organisms. Vitamin A activity was found to be characterised by the combination of a β -ionone ring with a carbon chain of 4-5 conjugated double bonds. Therefore only a few of the carotinoid pigments discovered could give rise to vitamin A in the animal organism. These were α -carotene, β -carotene, γ -carotene, and kryptoxanthin, together with some of the derivatives of carotinoids e.g., semi- β -carotenone, semi- β -carotenone-oxime, β -oxy-carotene, and dehydro- β -semi-carotenone. All the other carotinoids given in the table have no vitamin A value.

It would be of some interest to point out that β -carotene is twice as active as α - or γ -carotene or kryptoxanthin, because it gives rise to two molecules of vitamin A while others only to one. The vitamin A activity of papaya and yellow maize is almost entirely due to kryptoxanthin. The yellow pigment of most green leaves is predominantly β -carotene but the pigment of carrots, red palm oil, mango etc., contains a high percentage of α -carotene. The pigment of tomato is lycopene which has no biological activity but it also contains some carotene to which its vitamin A action is due.

We come now to the most important question of the metabolism of carotene. There are two aspects of this question which have been the subject of numerous studies:

- (i) Absorption of carotene from the intestinal tract. Carotene is a water insoluble pigment. In what form is it absorbed and what are the factors which control its absorption?
- (ii) Transformation of carotene to vitamin A. In what organ and under what conditions does this change take place? What is the mechanism of this change? Can this change be imitated *in vitro*?

These problems have not been settled with the same degree of success which the organic chemist has attained in the elucidation of the chemical structure and the properties of the carotinoids. One fact however seems to be definitely established, that in the absence of fat in the diet carotene is not so well absorbed. This has been definitely proved by a number of our studies. With a normal amount of fat in the diet, 70-90% of the carotene might be absorbed, while if fat is excluded from the diet almost 70-80% of carotene given might be recovered from the faeces. There is no evidence that 10% fat will mean greater absorption than with 5%.

It has been suggested that bile acids might possibly form soluble and diffusible compounds with carotene and thus help in the absorption of carotene. Greaves and Schmidt have studied this question, and obtained some evidence in support of this view.

With respect to the question of the transformation of carotene into vitamin A in the animal organism attention has been focussed on two organs, (i) the intestinal tract and (ii) the liver.

With regard to the intestinal canal it was conjectured that the activity of intestinal bacteria might bring about the transformation. This however seems unlikely to be the normal mode of change in the organism since after ingestion of carotene quite a lot of the pigment is present in the blood serum, in the liver, and other organs of the body, which shows that carotene is absorbed as such and later on broken up into vitamin A.

Since liver is the chief storehouse of the vitamin in the body the general consensus of opinion is that transformation takes place in that organ. However any direct and conclusive evidence has not so far been obtained to that effect.

Some years ago liver perfusion studies were carried out by us. A colloidal solution of carotene was slowly perfused into the liver of anaesthetised animals through a canula attached to one of the splenic veins. A small piece of the liver was cut off before the perfusion to act as a control. The animals did not live very long after the operation. The longest that an animal lived was 18 hours and as much as 1-10 mg. carotene was perfused but no evidence of the transformation of carotene into vitamin A was obtained either chemically or spectroscopically. One most striking fact in these experiments was that carotene rapidly disappeared from the blood. Even within a few minutes after the perfusion was complete, no trace of carotene was to be discovered in the blood.

The animals used in these experiments were cats. Unfortunately it was later discovered that cat as a species lacks the power of transforming carotene into vitamin A. Young cats kept on skimmed milk and lean meat for long periods could be partially depleted of their reserves of vitamin A but the daily administration of even large doses of carotene, as much as 10 mg. daily for two or three months did not result in the formation of any vitamin A in the liver. On feeding cod liver oil considerable deposition of vitamin A in the liver took place.

When a colloidal solution of carotene was injected intravenously into an animal, the pigment rapidly disappeared from the blood and was localised chiefly in the liver, the spleen and the lungs. During the

course of the next few days the pigment tended to disappear from the liver but it could not be experimentally shown that the disappearance of the pigment was attended with the concomitant appearance of vitamin A. The rapid disappearance of the pigment from the blood suggested phagocytosis, its presence in Kupffer cells, and its localisation in the organs, which are the main seats of the reticulo-endothelial system, suggested that the reticulo-endothelial system might have something to do with the transformation, on the analogy of the mechanism of the formation of antibodies. Attempts were made to study this aspect by blocking the reticulo-endothelial system with Indian ink or dyes in vitamin A-deficient rats and then feeding them with carotene, taking the disappearance of the symptoms of deficiency or the storage of the vitamin in the liver to be a criterion of the ability to utilize carotene. The results were highly suggestive but inconclusive.

The problem was also studied in heptectomised rats. It was expected that rats from which the spleen was removed might have less ability to change carotene into vitamin A than normal rats, since removal of the spleen meant the removal of a part of the reticulo-endothelial system, although possibly removal of a part might also lead to the active proliferation of the reticulo-endothelial cells in other organs of the body. However the results were again inconclusive. Thus so far no direct and conclusive evidence has been possible to obtain to prove that the transformation of carotene into vitamin A takes place in the liver.

A few words might be said on the attempts to convert carotene into vitamin A *in vitro* with the

help of liver tissue or other means. In 1931 attempts were made to see whether intestinal bacteria or minced liver tissue when incubated with colloidal suspension of carotene would lead to the formation of vitamin A. Experiments were repeated under a variety of conditions but without any marked success. But in certain experiments with certain strains of intestinal bacteria under anaerobic conditions a substance was produced which gave intense blue colour with a violet tinge with antimony trichloride reagent. However the substance was too labile for a spectrographic test to be made and the conditions under which it was formed could not be determined and could not always be reproduced.

Finally one more study may be described. Most of our earlier experiments were tried with liver extracts in minced liver tissue. It is possible that the change could take place only if the integrity of the cells is maintained.

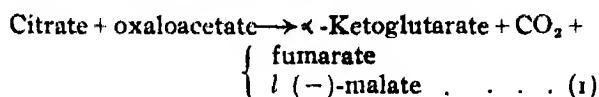
A number of vitamin A-deficient rabbits were fed with carotene. After about 24 hours the livers were aseptically excised out and dropped into molten wax at 45-46°C which was rapidly cooled. These were kept at room temperature and allowed to autolyse. A piece of the liver was examined immediately for its content of carotene and vitamin A. The other pieces were examined after 15, 21, and 28 days. Carotene was estimated colorimetrically and vitamin A by the SbCl_3 reaction. It was observed that during the course of autolysis carotene disappeared while the vitamin A content of the tissues increased.

Research Notes

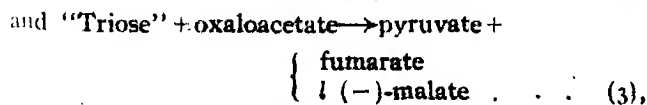
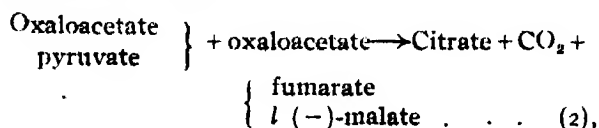
The Citric Acid Cycle and the Szent-Györgyi Cycle

H. A. KREBS (*Biochem. J.*, 34, 775, 1940) puts forward new evidences supporting his "citric acid cycle" in respiration of tissues and also defines the relation between the "citric acid cycle" and the "Szent-Györgyi Cycle" in pigeon breast muscle. He is of opinion that the oxidation of a "triose" equivalent involves one complete "citric acid cycle" and three repetitions of the "Szent-Györgyi Cycle"; and that the "Szent-Györgyi Cycle" is concerned with the transport of (at least) 6 of the 12 H atoms released during the oxidation of one "triose" equivalent.

In support of his theory he describes another reaction in which oxaloacetate is reduced:



From the above as well as the following two reactions known before



he points out that the "Szent-Györgyi Cycle" acts as a hydrogen carrier in oxidation of citrate (1), in the formation of citrate (2) and in the oxidation of "Triose" to pyruvate (3).

A. R.

Synthesis and Breakdown of Starch in Plants

SYNTHESIS of starch in higher plants which primarily occurs as a result of photosynthesis is followed by its degradation into sugars for translocation and also for metabolic purposes. The reverse reaction also takes place simultaneously specially in the storage organs. The intermediary role of phos-

phorylated sugars in the breakdown of carbohydrate by yeast and certain animal tissues has been thoroughly elucidated. Naturally it is believed that a similar process takes place during the rapid interconversion of carbohydrates in higher plants. The isolation of Robison ester and Cori ester-like substances from plant materials by various workers has confirmed the idea that such interconversion also depends upon the formation of labile phosphorylated derivatives of sugars. Information regarding the types of enzymic mechanism responsible for the various aspects of this metabolic problem in the plant is still very meagre. C. S. Hanes (*Proc. Roy. Soc. B*, 128, 421, 1940) gives a preliminary report of his observation carried out with enzymes from mature pea seeds to elucidate the above phenomenon.

Finely powdered pea seeds (Laxton's Progress), freed from fat was extracted in distilled water for 40 hours in presence of toluene. This crude aqueous extract has been found to consist of an amylase, a phosphorylase and a phosphoglucose conversion system. The first recognisable step in the activity of the phosphorylase is the formation of non-reducing acid-labile glucose-1-phosphate which has been isolated in the form of the crystalline potassium salt. It is interesting that the conversion of starch to glucose-1-phosphate is a reversible reaction and is catalysed in both directions by the phosphorylase. Thus when glucose-1-phosphate is added to the pea extract it becomes partially converted into a polysaccharide resembling starch, and inorganic phosphate is liberated.

In an alternative reaction glucose-1-phosphate is converted into acid-resistant reducing hexose-monophosphates, of which a considerable proportion has been shown to consist of 6-phosphoric esters of glucose and fructose. This transformation is catalysed by two or more enzymes constituting the phosphoglucose conversion system.

Finally, when crude extracts of peas are allowed to act upon starch, in the presence of inorganic phosphate, fructofuranose-1:6-diphosphate is formed. The dialysed extract does not give this product. A dialysable co-enzyme is probably required by the mechanism concerned in this phosphorylation.

The results indicate that the phosphorylase is able to act upon a much wider range of carbohydrate substrates than is generally believed to be the case with the phosphorylases from muscle and yeast. It seems that almost any saccharide composed of l-glucopyranose units linked in positions 1 and 4 (as in maltose) may serve as substrate regardless of the length of the chain. There is indication to show that an endwise degradation occurs during the phosphorylation. These observations together with the fact that glucose is not esterified directly are in harmony with the hypothesis that l-glucose chains are degraded by the phosphorolytic cleavage of terminal glucose units, these being liberated successively, from the non-aldehydic chain-ends, in the form of glucose-1-phosphate.

H. N. B.

Radioactive Iron as an Indicator in the Study of Iron Metabolism

It is well known that iron deficiency is a primary factor in anaemia. Despite much conjecture, little definite knowledge is available about the mechanism of absorption and excretion, and mechanism for the transport and mobilisation of iron reserves of the organism. Radioactive isotopes have recently been very much available through the development of the cyclotron by Lawrence *et al* so that there has been very valuable and exhaustive researches in various laboratories on intermediary metabolism with the help of such "labelled" molecules.

Austoni, Rabinovitch and Greenberg (*Jour. Biol. Chem.*, 134, 27, 1940) have studied the absorption, distribution and excretion of iron in normal and iron-deficient rats with radioactive iron as an indicator.

As data on the iron content of blood-free tissues and organs of rats in varying metabolic states are not available, these authors developed a technique of viviperfusion to free the tissues very thoroughly of their contained blood. In a preliminary experiment

analysis was performed with tissues of normal rats, of rats made anaemic, and of iron-enriched rats.

The data, in general, showed a decrease in the iron content of most of the tissues of anaemic rats, the liver and spleen being most strongly depleted. Iron enrichment attained by feeding ferric chloride leads to an increase in the iron content of most of the tissues, the bone marrow showing the greatest gain.

Experiments were next carried out by administering radioactive iron to two groups of rats, normal and iron-deficient. Hemoglobin values for each animal were determined at weekly intervals. The radioactive iron, in solution as ferric chloride, was administered to the rats by stomach tube. The animals were then placed in individual metabolism cages over a device permitting separate collection of urine and faeces, and were fed the stock colony diet.

After the desired period had elapsed, the rat was anaesthetised, a blood sample was drawn and the animal viviperfused. The blood and desired tissues were separated and analysed for their radioactive iron content either with a Lauritsen electroscope or with an ionisation electrometer.

It is found that a single dose of iron requires 12 hours to pass from the stomach and small intestine. Anaemic animals eliminate less of the administered iron in stool or urine. Where normal animals retain 30%, the anaemic animals retain 50% of the iron administered.

The specific accumulation of the absorbed iron per gram of tissue was greatest in the bone marrow, blood, spleen, liver and heart. Total accumulation was greatest in muscle and blood particularly in anaemic rats.

In normal rats, after 10 days, the radioactive iron nearly disappears from the muscle and blood but in case of anaemic animals it accumulates considerably.

The present investigation represents the first reported study of the passage of iron through the gastrointestinal tract with radioactive iron as a tracer.

H. N. B.

BOOK REVIEW

The Position of Women in Hindu Civilisation (from prehistoric times to the present day)—by DR A. S. ALTEKAR, M.A., LL.B., D.Litt., Manindrachandra Nandi Professor, Benares Hindu University. Published by Culture Publication House, Benares, 1938. Pp. xi+468, with 8 plates. Price Rs. 6/-.

In the work under review the author attempts to give an exhaustive account of the position and status of women in Hindu society from the earliest times down to the present day. The book is divided into twelve chapters. Chapter I deals with the childhood and education of Hindu girls in different ages, Chapter II with their position regarding marriage and divorce, and Chapter III with their married life. Chapters IV and V give an exposition of the status of widows, the former dealing with problems connected with the *Sati* and the latter with those of levirate and remarriage. Chapter VI discussing Hindu women in public life gives an account of the *Purda* system and also of women as rulers and administrative officers. Chapter VII discusses women's position in the Hindu religion, and Chapters VIII and IX their proprietary rights. Chapter X gives an account of the dress and ornaments popular with Hindu women in different ages. Chapter XI deals with the general attitude of the Hindu society towards women, and Chapter XII gives a retrospect together with some observations regarding the solution of several modern problems confronting Hindu women. There is a number of plates illustrating the dress, ornaments, etc., popular with the women of ancient India.

The vast Indian subcontinent is known to be equal to Europe with all its countries but Russia, and the Hindu population is made of numerous tribes belonging to different grades of civilisation and alien ethnic types. Even the earliest authorities on *Smriti* therefore had to recognise dissimilar customs for different parts and peoples of India (cf. Bodhayana on cross-cousin marriage amongst the peoples of the Deccan). The factor of local or tribal variation in the development of customs, the cross-currents of different culture and the lack of requisite data make

a study of the evolution of Hindu society exceptionally difficult. Prof. Altekar however should be congratulated on his valuable work in spite of these limitations of the subject itself. He has tried to utilise all available materials and sources of information regarding Hindu women of all ages with reference to causes of the subsequent change in their position. He has also often attempted to indicate lines whereon the problems now facing Hindu girls may be tackled so as to get satisfactory solutions. His views are sympathetic and liberal, and his criticisms generally sober and impartial.

The nature of the subject and the sources of information, however, leave room for difference of opinion amongst scholars, and readers may not agree with the learned professor on all points. The reviewer does not agree with the author when he says that the *Purda* system was beginning to be popular with some royal families only about 300 A.D. (p. 200). The derivative meaning of the word *orodhana* (= *avarodhana*, *avarodha*, restraint) to indicate women's apartment in the houses of Asoka's brothers and sisters (Rock Edict V), Kautilya's description of the *antahpura*, and the *Mahabhashya*'s references (1.1.6; 2.1.1 etc.) to *asuryampasyani mukhani* (faces not seen even by the sun) prove that *Purdas*, specially in royal families at least in some parts of India, is certainly much earlier. Book III of Chapters III-IV of the *Arthashastra* definitely proves the existence of strict *Purda* even in ordinary families.

Prof. Altekar is no doubt an able collector of materials. Since however they are scattered over a vast field, it is only natural that a few of them have escaped the learned scholar's notice. In the section dealing with queens reigning in their own right (p. 218 ff) some of the most important examples, those of the Kakatiya queen Rudhamba (c. 1260-91 A.D.) who succeeded her father Ganapati, and of Dandimahadevi (c. 886-93) and her mother both of whom succeeded king Subhakara of Orissa, have not been noted. Rudramba is no doubt the queen ruling over the Guntur district at the time of Marco Polo's visit to India (p. 224). In this connection, moreover, the administrative capacity of Bhavani of

Bengal and Jhunda (or Jhindan) of the Punjab can hardly be ignored. The learned professor again does not notice any early instance of *Sati* in the Deccan (p. 150 ff). According to many scholars, however, the Kavadi stone inscription (*Ep. Carn.*, VIII, p. 167) records the death of Kadamba Ravi-verman (C. 490-538 A.D.) and his queen "who probably became a *Sati*."

Similar other points may be cited, but they do not detract in any way from the value of Prof. Altekar's work. We are sure that students of Indian history, especially those interested in the study of Indian society, will be benefited by a perusal of his book.

Dines Chandra Sircar

Coal Carbonisation and Some of its By-products

—by B. WILSON HAIGH. Reprinted from the *Transactions* of the Mining, Geological and Metallurgical Institute of India.

The paper on a highly interesting subject like coal carbonisation from Mr Wilson Haigh, the manager of Bararee Coke Company, Jharia, with over 30 years' experience in this line is quite welcome and a timely one when people are taking keen interest in the matter of industrial development of mineral resources of India. The author has dealt with the subject of medium-temperature and low-temperature carbonisation in brief but the subject of high-temperature carbonisation with a view to recover a number of useful by-products has been discussed in a more exhaustive manner. With regard to the question of immediate possibility of starting medium-temperature carbonisation (800°C) to manufacture smokeless patent domestic fuel the following remarks of the author are worthy of consideration "... the time is near when coke-oven owners in India will need to turn their attention to producing a coke suitable for the domestic market as there are now in existence more by-product ovens than are required to produce all the coke that the metalliferous industries can absorb" ... "Such domestic coke would have to compete with the soft coke made from low grade coals in heaps or mounds at many collieries in the Jharia and Raniganj fields. This coke is sold at a very cheap rate as there is no capital expenditure involved in its manufacture. Speaking generally, it is a low-grade fuel, dirty and high in ash" ... "If a demand for a clean, readily ignitable fuel at a higher price can be created and developed there must be a great potential market in northern India and in large cities like Calcutta. No doubt many difficulties have to be faced, one of which will be to educate the public to appreciate the

advantages of such a fuel. A highly-developed marketing organisation would need to be established"

In face of these remarks it would be better if the Soft Coke Cess Committee instead of doing propaganda work for the sale of soft coke produced at present by crude methods directed their attention to encouraging the coke-oven owners to produce better domestic coke. The propaganda for this better commodity would meet with success.

With regard to the establishment and successful working of a well-planned and fully equipped low-temperature carbonisation plant in this country, the author has expressed sufficient doubts as the capital cost of such plants would be very high and as the other by-products might not be recovered with clear margin of profit under the existing conditions of market. Such statements from a practical man of sufficient experience cannot be ignored but on the other hand should be carefully scrutinised by those interested in this line. The Bihar Government in particular, who have already invested some money in starting series of experiments in connection with low temperature carbonisation, should give Haigh's comments a special consideration.

The subject of high-temperature carbonisation for the manufacture of metallurgical coke and for the recovery of many useful by-products such as coal-tar, ammonia, naphthalene, benzole etc., has been described in the paper.

The author has also dealt with in brief the subject of coal tar distillation for the manufacture of road tar, pitch, creosote oil, middle oil, disinfectants and antiseptics, coal tar colours, perfumes and flavours, plastics, medicinal and surgical substances, photographic chemicals, etc. Some of these common by-products such as tar, ammonium sulphate, naphthalene, creosote oil, road tar, coal tar pitch, disinfectants, carbolic acid, motor benzole, toluene, naphtha are already being recovered in the Bararee coke ovens, Jharia. Road tars Nos. 1, 2 and 3 to the British standard are now manufactured in India and it is gratifying to note that the use of road tar has quadrupled during the last quinquennium and it is expected to still further increase in near future with further expansion of tarred roads in this country.

The subject of recovery of benzole, the liquid fuel from coal gas is very important and has been dealt with in a comprehensive manner. The Bararee Coke Co., Ltd. were the pioneers in this direction (in 1920) and they were succeeded a few years later by the East India Railway plant at Giridih. The total annual output of the two plants does not exceed 2 lakhs of gallons whilst the potential output

of existing coke plants is about three to four million gallons. Some may think that the reason for India's low production is owing to the difficulties of recovery due to tropical conditions but the real reason, according to Mr Haigh, is to be found in the attitude of the Central Government, especially with regard to imposition of excess duty. This duty applies to petrol, benzole and alcohol alike. The cost of petrol at Indian ports is 3 annas per gallon whereas it costs, say, four times as much to produce a gallon of benzole and as they are both subjected to the same excise duty, benzole is automatically shut out of the motor-spirit market in competition with petrol. In other countries different conditions prevail. In Great Britain for instance benzole has always enjoyed a preference. The future development of the benzole industry in India, therefore, entirely depends on the drastic change in the policy of the Central Government.

The author remarks that it is manifestly impossible for any new companies in India to take up the manufacture of benzole or any motor-spirit from coal by any process without some form of Government assistance either by way of subsidy or remission

of excise duty. This should, therefore, seriously engage the attention of the Government, who are responsible for the country's welfare. As Indian benzoles are rich in toluol there is every possibility of manufacturing high explosives (T.N.T.) from the toluol, provided the benzole industry develops under the care and protection of the India Government. The author's discussion of the subject of alcohol (derived from molasses) -petrol mixture as proposed by the U.P. and Bihar Governments is also worth a careful consideration before the proposal is actually made compulsory. According to him alcohol-petrol-benzol mixture would be a superior fuel to the alcohol-petrol mixture and both benzole and alcohol could be obtained from coal.

A large number of illustrations in the paper has made it highly interesting and instructive. Many of his suggestions seem to have practical bearing and the object with which the paper was probably written would be served if some interest is created in the minds of those who are seriously considering the question of industrial development of India.

N. N. Chatterjee

LETTERS TO THE EDITOR

Cashew Apple, a Rich Source of Vitamin C.

Before proper planning of the nutrition of the people is taken up in any country, it is essential that the approximate amounts of the protective principles present in the various foodstuffs grown locally should be known. This necessarily implies that foodstuffs specially rich in any particular dietary factor deserves serious notice in nutritional planning.

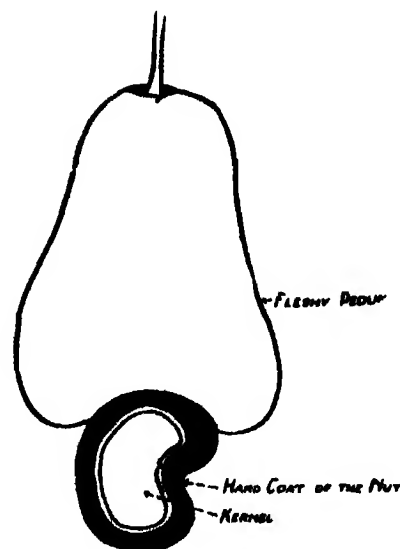
As far as the content of vitamin C in locally grown edibles is concerned, two kinds of fruits and one kind of vegetable have so far been described to be very rich (more than 200 mgs. per 100 gms. of the material) in this particular element. They are guava (*Psidium guajava*) described by Ghosh and Guha¹ and by Ranguathan,² Indian gooseberry (*Emblica officinalis*) described by Giri and Doctor³, and Kankrol or Kheksa (*Momordica cochinchinensis*) described by Mitra *et al.*⁴

During routine examination of edibles for food value in the present author's laboratory it was found that cashew apple or the fleshy peduncle of cashew-nut or *Hijli badam* (*Anacardium occidentale*) is another rich source of vitamin C. This vitamin was assessed by the chemical method with 2:6 dichlorophenolindophenol and carotene by colour matching as described in a previous communication by Mitra *et al.*⁴ The other proximate principles were determined by the usual methods suggested by the Association of the Official Agricultural Chemists, America, with slight modifications.

Food value of Cashew apple per 100 gms. of the material.

Moisture	...	...	86.18 gm.
Protein	...	...	0.81 gm.
Fiber extractives	...	...	0.60 gm.
Mineral matter	...	...	0.37 gm.
Carbohydrate	...	...	11.14 gm.
Calcium	...	...	4.0 mgm.
Phosphorus	...	...	20.0 mgm.
Carotene	...	...	0.09 mgm.
Ascorbic Acid	...	...	261.5 mgm.

Cashewnut belongs to the natural order Anacardiaceae. The flowers are polygamous and each has one carpel yielding a kidney shaped nut with hard acrid coat. Under it the axis swells up into a pear like body, fleshy and edible. It is this fleshy



Cashew Nut (*Anacardium occidentale*).

peduncle which when ripe and yellow is known as cashew apple. Before subjecting the apples to analysis the parchment-like outer coat was removed.

The nut is grown extensively in South India. In Bombay, Bengal and Orissa a fair amount is also grown. The kidney-shaped nut is a popular article of diet over large parts of India. The fleshy peduncle when fully ripe is eaten either as fruit or cooked as vegetable. An alcoholic liquor is said to be fermented out of the cashew apple in South India (Mangalore). In Midnapur district (Bengal) the fresh juice of the apple is still used in the villages as a local antidote against snake venom. The nuts, when ripe, are roasted, shelled and kernel exported outside. Of total exports outside India a little more than 80% is shipped to the American countries.

The kernel of the nut was not analysed for its food value as this has already been done in Coonoor

*Production and export figures of the nuts.**

Province or State.	Production in tons.	Export in tons.
Bengal ...	1,200	not known
Bombay ...	4,500	850
Cochin ...	5,000	4,750
Madras ...	22,500	12,945
Orissa ...	560	380
Travancore ...	10,000	8,000

* Figures supplied by the respective marketing officers and are approximate.

laboratories and results published by Rangnathan *et al*⁵.

The author is obliged to his friend Professor S. S. Chaudhury of the Prince of Wales Medical College, Patna, who has kindly procured the samples from Orissa for analysis and to his chief Lt.-Col. S. L. Mitra, I.M.S., for advice and encouragement.

Nutrition Scheme,
Public Health Laboratories,
Bankipur, Patna, 4-8-1940.

K. Mitra.

- ¹ Ghosh and Guha, *Jour. Ind. Chem. Soc.*, 12, 30, 1935.
- ² Rangnathan, S., *Ind. Jour. Med. Res.*, 23, 241, 1935.
- ³ Giri, K. V. and Doctor, N. S., *Ibid*, 26, 167, 1938.
- ⁴ Mitra, K. *et al*, *Jour. Ind. Chem. Soc.*, 17, 250, 1940.
- ⁵ Rangnathan, S. *et al*, *Ind. Jour. Med. Res.*, 24, 699, 1937.

On New Diffraction Maxima in Laue Photographs

It has been reported recently by Sir C. V. Raman and Nilakantan¹ that a new type of diffraction maxima has been observed by them in the Laue photographs of diamond and crystals of sodium nitrate. The explanation offered by them regarding the origin of these maxima is that when X-ray quanta impinge on any set of planes of a crystal lattice, the characteristic vibration of the lattice is excited and if the glancing angle be other than a right angle, the phases of motion of different atoms of the plane are

adjusted in such a way that the planes become slightly inclined to the original position during the vibration. Hence the monochromatic X-rays are reflected when the new orientation of the planes satisfies the Bragg relation even if, in their original position, the Bragg relation is not satisfied and the wavelength in question is not reflected by these planes. It has been pointed out later on by Knaggs *et al*² that such diffraction maxima have been observed by a large number of workers from time to time since 1913, and more experimental investigation is necessary before any theory can be accepted as essentially correct. A detailed mathematical theory has, however, been put forward by Zachariasen³ and it is the purpose of this note to point out that this theory can explain the origin of the new diffraction maxima quite satisfactorily, while the observed facts are in disagreement with the hypothesis proposed by Sir C. V. Raman and Nilakantan.

The disagreement between the observed facts and the hypothesis mentioned above may be summarised as follows: First, the displacement of the atoms from their original positions required to give the new maxima in the observed direction is too large to occur actually in the crystal. Secondly, the intensity of the new maxima should not depend very much on the variation of the angle of incidence from the Bragg angle, but actually it depends very much on this variation. Thirdly, the direction of new diffraction maximum should make an angle $2\theta_B$ with the direction of the incident X-rays according to the proposed hypothesis, but actually the angle observed is sometimes less and sometimes greater than $2\theta_B$. Fourthly, in the case of diamond the frequency of the characteristic vibration is such that $h\nu \gg kT$ at temperatures below 1000°C and hence the thermal excitation of this vibration is not possible at any temperature below 1000°C , but actually it is observed that the intensity of the new diffraction maxima increases appreciably in the case of diamond when the crystal is heated to 500°C .

According to the theory put forward by Zachariasen, the diffuse scattering owing to thermal vibration of the lattice has a maximum in the direction making an angle $2\theta_m$ with the incident rays given by the relation,

$$2\theta_m = 2\theta_B + 2\Delta \sin^2\theta_B \quad (1)$$

where θ_B is the Bragg angle and $\Delta = \theta_i - \theta_B$, θ_i being the glancing angle of incidence. In the following table the values of θ_m calculated for different glancing angles observed in the case of diamond are compared with those calculated according to (1). It is observed that there is fair agreement within experimental errors between the observed and the calculated values.

TABLE 1

Glancing Angle		$2\theta_B$	$\theta_i - \theta_R = \Delta$	$2\theta_B + \Delta \sin^2 \theta_B$	$2\theta_m$
Incidence	Reflection				
17° 11'	24° 33'	43° 56'	(4° 47')	42° 36'	41° 44'
18° 41'	23° 50'	43° 56'	(3° 17')	43° 1'	42° 31'
20° 49'	22° 43'	43° 56'	(1° 9')	43° 37'	43° 32'
21° 4'	19° 6'	39° 30'	(1° 19')	40° 58'	40° 10'

Thus the discrepancy between the Bragg angle and the observed angle of reflection for the new maxima is accounted for by Zachariassen's theory. According to this theory the intensity of the maxima diminishes very rapidly with the increase in the value of Δ and the intensity should also increase with the increase in the temperature of the crystal. The observed facts are quite in agreement with these conclusions. Thus the new maxima are probably parts of diffuse scattering owing to thermal vibration of the crystal and not a specular reflection as proposed by Sir C. C. Raman and Nilakantan. Details are given in a paper communicated to the *Proceedings of the National Institute of Sciences, India*.

The writers are indebted to Prof. M. N. Saha, F.R.S., for his kind interest in the work.

Palit Laboratory in Physics,
University College of Science,
Calcutta, 9-8-1940

S. C. SIKKAR.
J. GUPTA.

¹ Sir C. V. Raman and P. Nilakantan, *Proc. Ind. Acad. Sc.*, 11, 379, 1940.

² Knaggs *et al.*, *Nature*, 145, 820, 1940.

³ W. H. Zachariassen. *Phys. Rev.*, 57, 597, 1940.

Preservation of Cotton Fabrics

Formaldehyde (HCHO) fume is very effective for the preservation of cotton fabrics.

A Naga and a few Santal cloths including 'Sarces' were brushed very carefully. Some of them were starched. The specimens were subjected to the following treatment. 20 oz. of water and 2 oz. of formaldehyde solution (40%) were put in a tin canister (specially made for our laboratory purpose). The canister is open at its top and is 18" x 9" x 9" in size. At a height of 6" from the bottom 4 brackets are welded at the corners. A moveable plywood box with a hole at its bottom (diameter—5") and with the opposite end completely open, is placed on the brackets. A fine sheet of wire-gauze is placed on this opening of the box so that no article may fall down. The fabrics were kept on it and the canister was placed over a Bunsen burner on a stand. A wooden lid made to fit the canister exactly was placed on the top.

The fabrics were fumigated for ten minutes, after which the burner was put out. The articles were taken out after 24 hours and the treatment appears to be very satisfactory. To dry up the little moisture they absorbed, the fabrics were kept in open air for several minutes (but not in the sun).

Afterwards the cotton fabrics were kept inside a Tarine moth-proof bag. A pound of naphthalene was also put into it. The mouth of the bag was closed and it was hung on its hooks from the wall. The specimens were examined every two months.

EXPERIMENTAL DATA :—

PRESERVATION OF COTTON FABRICS

Specimen.	Condition of specimen.	Reagent.	Date of treatment.	Period for which the specimen was under observation.	Result.
Naga waist cloth. C. 824	Old	Formaldehyde vapour	March 1938	2 Years, 4 Months	Good. No attack of Moths.
Santal Doal Saree. C. 517	New	Ditto	December 1938	1 Year, 7 Months	Ditto
Santal Saree. C. 530	Ditto	Ditto	February 1939	1 Year, 5 Months	Ditto
Santal cloth. C. 726	Ditto	Ditto	March 1940	4 Months	Ditto

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35, Ballygunge Circular Road,
Ballygunge, 30-7-1940.

Minendra Nath Basu.

On Hierarchical Sampling, Hierarchical Variances and their connexion with other aspects of Statistical Theory

From a non-homogeneous univariate statistical population we can estimate the mean by a number of alternative methods one of which is a particular type of sampling recently proposed to be extensively used by P. C. Mahalanobis in crop-cutting experiments. Suppose the population in question is such that it could be cut up into a number of district zones (which let us call zones of the first order), each of these could be further cut up into a number of zones (which we call zones of the second order), each of the second order zones could be cut up further into a number of third order zones and so on till finally we get to zones of the $(k-1)$ th order, each of which is a statistically homogeneous group. Suppose that the variance 'within' the $(k-1)$ th order zones be σ_k^2 , 'between' the $(k-1)$ th order zones but 'within' the $(k-2)$ th order zones be σ_{k-1}^2 , 'between' the $(k-2)$ th order zones but 'within' the $(k-3)$ th order zones be σ_{k-2}^2 , and so on till we come to the variance 'between' the 1st order zones which we denote by σ_1^2 .

Our statistical population is said to be hierarchical if these variances $\sigma_1^2, \sigma_2^2, \dots, \sigma_k^2$ happen to be of entirely different orders. Now suppose further that from such a population we sample in the following manner: from the 1st order zones, we select at random n_1 zones, from each of these we select at random n_2 second order zones and so on and finally from each selected $(k-1)$ th order zone, we pick out at random n_k individuals. We have altogether $n_1 n_2 \dots n_k$ observations at our disposal; such a sampling has been called nested or hierarchical sampling by P. C. Mahalanobis. The mean of these observations is supposed to estimate the unknown population mean. The variance of the estimated mean could be easily shown (by the *Algebra of Mathematical Expectations*) to be given by

$$\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_1 n_2} + \dots + \frac{\sigma_k^2}{n_1 n_2 \dots n_k} \quad (1)$$

If we call our variate x_k and introduce pseudo-variates x_1, x_2, \dots, x_{k-1} such that x_1 numbers, as it were, the first order zones, x_2 the second order zones and so on and finally x_{k-1} numbers the $(k-1)$ th order zones and if further we assume a multivariate normal distribution for the variates (x_1, x_2, \dots, x_k) , then we have shown that formula (1) could be derived in an elegant manner. This derivation of (1) involves certain restrictions no doubt and thereby robs (1) a little of its generality but at the same time this process of derivation gives a greater insight into certain aspects of the multivariate normal dis-

tribution and incidentally gives a neat statistical interpretation of the rectangular statistical co-ordinates introduced by one of us jointly with Mr R. C. Bose in a paper¹ entitled "Normalization of Statistical Variates and the use of Rectangular Co-ordinates in the Theory of Sampling Distributions" published in 1937 in *Sankhya (Indian Journal of Statistics)*.

For a fixed set of values of $(x_1, x_2, \dots, x_{k-1})$, x_k is normally distributed about a mean M_{k-1} which is a function of $(x_1, x_2, \dots, x_{k-1})$ but with a variance which is independent of the particular values of this set. This variance is σ_k^2 ; again M_{k-1} itself is distributed for a fixed set of values of $(x_1, x_2, \dots, x_{k-2})$ about a mean M_{k-2} , which is a function of $(x_1, x_2, \dots, x_{k-2})$ with a variance which is independent of the particular values of this set; this second variance is σ_{k-1}^2 ; and thus it goes on till we get to M_1 which is a function of x_1 , and which is normally distributed about a constant M_0 with a variance which is σ_1^2 .

It is of considerable interest to note that these variances $\sigma_1^2, \sigma_2^2, \dots, \sigma_k^2$ with their direct statistical import could be completely identified with the rectangular (statistical) co-ordinates for the (multi-variate-normal) population introduced in the paper referred to above. This furnishes us, with a simple statistical interpretation for those co-ordinates which was lacking in 1936, when these co-ordinates were first introduced as fruitful auxiliaries for certain investigations in Mathematical Statistics.

Statistical Laboratory,
Presidency College,
Calcutta, 8-8-1940.

S. N. Roy.

Kalishankar Banerjee.

¹ *Sankhya*, 3, 1, 1937.

Generalised Boltzmann's formula and Planck's law

IN the usual Einstein's derivation of Planck's formula use is made of Boltzmann's law

$$\frac{n_2}{n_1} = e^{-(\epsilon_2 - \epsilon_1)/kT}, \quad (1)$$

where n_1 is the number of systems in state 1 of energy ϵ_1 and n_2 the number of systems in state 2 of energy ϵ_2 . This holds only when the systems obey the classical statistics. When this is not the case we have to use the generalised Boltzmann's law

$$\frac{A_2}{A_1} = e^{-(\epsilon_2 - \epsilon_1)/kT}, \quad (2)$$

where A 's are defined by

$$N_1(E) dE = \frac{a(E) dE}{\frac{1}{A_1} e^{E/k\tau} + \beta} \quad (3)$$

$$\text{and } N_2(E) dE = \frac{a(E) dE}{\frac{1}{A_2} e^{E/k\tau} + \beta} \quad (4)$$

$N_1(E)dE$ is the number of systems having their kinetic energy of translation lying in the range E to $E+dE$ and their internal state of motion characterised by the energy value ϵ_1 . $N_2(E)dE$ is the number of systems in the internal state ϵ_2 and with kinetic energies in the range E to $E+dE$. $a(E)dE$ is the number of states for the energy range E to $E+dE$. For the case of Fermi-Dirac statistics $\beta = +1$ and $\beta = -1$ for Bose-Einstein's statistics.

In the present note Planck's formula is derived by using the generalised Boltzmann's law and not the special relation (1) which holds only in the case of a classical gas.*

The rate of spontaneous emission will be $A_{21}N_2 \times (1 - \beta \frac{N_1}{a})$ where A_{21} is the transition probability of spontaneous emission and the factor $(1 - \beta \frac{N_1}{a})$ is introduced as usual in quantum statistics to take account of the "occupiedness of the levels"¹. The rate of stimulated emission will be

$$U_\nu N_2 B_{21} (1 - \beta \frac{N_1}{a})$$

where U_ν is the density of radiation of frequency ν and B_{21} is the transition probability of stimulated emission. Similarly the absorption rate will be

$U_\nu N_1 B_{12} (1 - \beta \frac{N_2}{a})$ where B_{12} is the transition probability of absorption. Equating the rates of emission and absorption, we get

$$N_2 A_{21} (1 - \beta \frac{N_1}{a}) + U_\nu N_2 B_{21} (1 - \beta \frac{N_1}{a}) = U_\nu N_1 B_{12} (1 - \beta \frac{N_2}{a})$$

which gives

$$U_\nu = \frac{A_{21} / B_{21}}{\frac{N_1}{N_2} \frac{B_{12}}{B_{21}} \frac{1 - \beta \frac{N_2}{a}}{1 - \beta \frac{N_1}{a}} - 1} \quad (5)$$

But from equations (3) and (4) we have

$$\frac{1 - \beta \frac{N_2}{a}}{1 - \beta \frac{N_1}{a}} = \frac{N_2 \frac{1}{a} e^{E/k\tau}}{N_1 \frac{1}{a} e^{E/k\tau}} = \frac{N_2}{N_1} \frac{A_1}{A_2}$$

Substituting this value in equation (5) and making use of relation (2), we obtain, since $\epsilon_2 - \epsilon_1 = h\nu$,

$$U_\nu = \frac{A_{21} / B_{21}}{\frac{B_{12}}{B_{21}} e^{h\nu/k\tau} - 1} \quad (6)$$

The constants in this equation are as usual, evaluated from the condition that for high temperatures equation (6) must reduce to the Rayleigh-Jeans formula, viz.,

$$U_\nu = \frac{8\pi\nu^2}{c^3} k\tau.$$

We have therefore

$$B_{12} = B_{21},$$

and consequently

$$U_\nu = \frac{8\pi h\nu^3}{c^3} \frac{1}{e^{h\nu/k\tau} - 1}$$

which is the Planck's formula for black body radiation.

University of Delhi,
Delhi, 26-7-1940.

Sukhdeo Behari Mathur
Badri Narayan Singh

* The frequency change in radiation due to Compton and Doppler effects is for simplicity not considered, i.e., we assume that the kinetic energy of the systems is unchanged by acts of emission and absorption of radiation.

¹ Jordan, *Zetts. f. Physik.*, 41, 711, 1927.

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On the Use of Science and Scientists

IN his anniversary address to the Royal Society Sir William Bragg, President of the Royal Society, makes the following remarks with respect to the use of science and scientists during times of peace as well as of war.

"There is indeed a widespread recognition of the general effectiveness of science. The ways of using science and scientific men are being slowly discovered. But the process is slow. It would, I think, be hastened, if certain fundamental truths were generally known and recognised. I venture to state them in the form of a few propositions:

1. Science, that is to say, the knowledge of Nature, is of fundamental importance to the successful prosecution of any enterprise.

For example, a nation is obliged to make all possible use of science in preparation for war, whether aggressive or defensive: and, again by way of example, in the maintenance of public health and social welfare. Of course, science is not alone in being a necessity in either case.

2. Science is of general application. There are not one science of chemistry, another of electricity, another of medicine and so on: there are not even distinct sciences of peace and war. There is only one natural world, and there is only one knowledge of it.

Experience shows that an advance in knowledge or technique or skill in any direction may be based on some item of knowledge acquired in a far distant field of research. For that reason, it is necessary to resist strongly a natural tendency for those who study science or apply it, to separate into groups without mutual communication.

3. Fruitful inventions are always due to a combination of knowledge and of experience on spot. Unless the man with knowledge is present at the place and the time when some experience reveals the problem to be solved he misses

the fertilizing suggestion. Neither can the mastering idea suggest itself to the man who has the experience only but no knowledge by which to read the lesson that the experience teaches. The man with knowledge may be a temporary or special introduction, or, which is much better, he may be the man who meets with the experience.

4. There are difficulties peculiar to the application of science to war purposes. While the war proceeds scientists as a body are anxious to put all their knowledge at the service of their country: but when the time comes they are anxious to get away to their work on pure science or the applications of science to the problems of peace. Government may preserve and most fortunately has preserved a nucleus of able scientific effort during the last 20 years of peace, so that a certain connexion is maintained between these particular applications and the general body of science, but from the very nature of their respective occupations, and on account of a certain secrecy which one of the two bodies is forced to maintain, the connexion is not always strong. It can easily happen that the solution of a particular difficulty in the war service may lie in some piece of knowledge far away from the immediate science of the enterprise and unknown to those who need it."

The urgency of using science for times of peace as well as of war was discovered only during the last Great War, and almost all western countries and Japan set up organisations for this purpose, with varying amount of success. In this matter, this country as usual has been nearly 25 years backward. There have been, in other countries, many defects in the use of science and scientists, but if these mistakes be carefully noted by the Government and leaders of this country, our lost opportunities may, to some extent, be retrieved.

It is believed that statement No. (1) will be universally agreed to, but (2) is not so readily recognised by those who have not got a scientific education. When a Government organisation is set up, it is usually devoted to one particular object, say, researches on synthetic dyes or on fuel technology or on synthetic drugs, on jute, cotton and other commodities. The workers in such institutes tend to be segregated into water-tight compartments particularly in this country, where even technological committees are filled up with a motley collection of members of the Assembly and the Council of State, members of Chambers of Commerce, I.C.S. men etc., chosen for no particular knowledge of the subject and of scientific methods; and inclusion of genuine men of science who can initiate fruitful lines of research and stimulate the investigators are not considered essential. It is not realised how much is lost because the workers in these institutions are thereby prevented from coming into contact with and under the influence of master minds in other sciences who may sometimes throw suggestions which may lead to solution of outstanding problems.

As regards (3) the principle has been recognised in the United Kingdom by the admission of scientists of a pure academic standing to such research associations as have been brought into existence for purely industrial work and the advantage of such associations has been illustrated in many cases in a very convincing manner. For example, the perfection of the recent methods of preservation of foodstuffs, cereals, and fruits (known as the refrigerated gas storage method) has revolutionised the whole technique, and it owes its success to the co-ordination between pure scientists and men who were acquainted with actual problems of food preservation in the Food Investigation Board created under the auspices of the Department of Scientific and Industrial Research. Many other examples may be given.

As regards No. (4), the problem is new to this country, because the Government, though it has been rather reluctantly forced to the view that scientific men should be mobilised at least for purposes of war, has not been able to take effective measures on account of inexperience, particularly in matters dealing with industry. But elsewhere, in England as well as in the enemy countries, science is being used very extensively and in a spectacular way for the prosecution of the war and in England the suggestion has been made that a Ministry of Science should form a part of every government.

Sir William Bragg does not like this idea because ministry would be too formal and rigid at any rate for immediate needs, and as far as our country is concerned, his remarks are all the more applicable because the Government departments in this country are not specially distinguished for promptness of decision or quickness of action. According to him the most successful way of using scientific knowledge should be personal and elastic. He thinks that the purpose will be served by attaching a central authority of science to the central authority of the country. This principle is to some extent followed in England in the Department of Scientific and Industrial Research, in the Medical Research Council and the Agricultural Research Council, but it does not suffice for the purpose as these organisations deal with a specific object, and are linked with the corresponding ministries. But for the application of science as a whole contact should be made between the rulers and eminent scientific men. He advocates the use of the Royal Society for this purpose. He suggests that a small group of Fellows selected for the purpose should be consulted by the Cabinet without hesitation whenever the need arose and it should be kept well informed by the members of the Government so that it might foresee occasions and needs.

Regarding the personnel of the new organisations which are being brought forward, Sir William Bragg is strongly of the opinion that even on the secretarial and administrative side, there should be men with a proper scientific training. The argument is reproduced in his own language:—

"There are two subsidiary consequences of the present position of science which need to be remembered. We have not long passed the stage, if indeed we have quite gone past it, when our knowledge of Nature is used as a reference library is used. The knowledge is there, on the shelves, to be taken down when anyone wants information on a particular point and happens to remember where possibly it may be obtained.

Anyone who wants to use a library effectively must already have some knowledge of the same nature as that which he hopes to find there. If not, he does not know where or how to look; nor can he grasp fully what he finds, even if he happens to hit upon the right book."

The importance of this suggestion can hardly be overestimated, particularly in this country. It is often found that many of the newer scientific organisations which are meant to put science and scientific men to the country's work are manned by members of the Civil Service or Audit Service having

absolutely no background of scientific knowledge, or, if they had any such knowledge while they were students, all vestige of that has been washed away in the dull routine of office work. As a glaring illustration we may point out that the posts of Director of Industries in most of the provinces have generally been reserved for such members of the Indian Civil Service for whom, for some mysterious reason, a berth has to be found somewhere outside the pale of administration, justice, or secretariat. While talking with such men about the scientific research needed for a particular line, it has been our experience that we were talking to a vacant mind, which has not been able to grasp the problems at all, and instead of coming to relevant points, finds pleasure in taking refuge behind vague and diffuse propositions. Such a man is just in the position of a candidate for an examination in some science subjects

who has not previous training in science, and cannot therefore find out the proper answer even when the best textbook is put in his hand. A good deal of inefficiency of the scientific departments of the Government of India is due to the continuance of this practice.

The Government of India has, as a result of the situation created by the war, brought out a new baby for the development of India's industries, namely, the Board of Scientific and Industrial Research. They hope to nurse the baby with the time-worn methods with which alone they have been familiar. We can only say that if these methods are rigidly followed, the baby will be found to be still-born. We therefore recommend for their serious consideration the advice given by the octogenarian president of the most famous scientific society in the world.

X-RAYS INTO FOSSIL REMAINS

A five-ton dinosaur that roamed the western part of the United States 80 million years or so ago has just had his teeth X-rayed. His jaw was removed from the American Museum of Natural History, New York, where it is normally on exhibition, to the works of the Westinghouse X-ray Company. There it was photographed by means of X-ray apparatus that is used in industrial work, and it was then discovered that there were four rows of uncut teeth inside the jawbone, in addition to the 36 that were visible to the eye. Altogether this dinosaur must have possessed over 500 teeth some of which had decayed. It is scarcely likely that he suffered from toothache, however, for in spite of his great size his brain was only the size of a man's fist and nervous system was poorly organised.

The dinosaur jawbone that was X-rayed in these experiments came from the lower left side of the mouth of a creature to which the formidable name of *Triceratops Serratus* has been given. It was dug from soft sand in Montana, a position suggesting that the creature had wandered into a quicksand and died when unable to struggle free. He is estimated to have been 50 years old when he came to this untimely end, and had then completed only a quarter of the average life of his kind. He stood 8 ft. high, and a tremendous shield stretching backwards from his head helped to protect his neck from his mortal enemy, a carnivorous dinosaur. He had two horns, each about 3 ft. in length, that projected forward over his little eyes, and a much smaller horn between his nostrils.

X-rays are proving particularly useful for examining rare fossil remains of this kind. Previously what was inside them could only be discovered by sawing 'windows' out of the bone. Now they can be examined without injury, and arrangements have been made for fossil finds of explorers on behalf of the American Museum of Natural History to be X-rayed by the Westinghouse X-ray Company.

Indian Scientists and the Present War

I shall refer first* to the creation of the Board of Scientific and Industrial Research. This Board has been created to bring the scientists in contact with industries, so that the vital problems of production and manufacture may engage the attention of all of us. As the Secretary pointed out in his report, your Association can legitimately claim its share in the creation of this Board. There is no doubt that the brilliant advocacy of this idea by your official organ "SCIENCE AND CULTURE" has borne fruit. This brings me immediately to the second important thing in which we are all interested namely our journal, "SCIENCE AND CULTURE". This journal and the *Current Science* have done yeoman's service to the cause of science in India. The Indian Science News Association has a very important function and part to play in the present times. Our learned President has remarked in his speech that the task of mobilising an army of scientific men is easy when compared with the task of educating public opinion in things scientific, and that the latter task is to be taken up in more earnest at the present time. I am glad that both these subjects are the Association's concern. I must confess that even our Government of which I am also a part now is not agile enough to appreciate the impacts of science on society. We are steeped in the bureaucratic methods of the old I.C.S. While the I.C.S. is still an efficient prime mover in the Government, it must be acknowledged that the present civilisation is largely based on applied sciences and a change in the angle of vision of the Government and the public is therefore clearly indicated.

It is not possible now to allow this laziness to resist the onward march of science. An interesting story of such laziness I heard when I was a student. It was reported that once a forest caught fire, and the officer on the spot sent a telegram to the authorities concerned asking for the necessary relief.

* Adapted from the speech delivered by Dr S. S. Bhatnagar as the guest-of-honour on the occasion of the fifth annual meeting of the Indian Science News Association held on the 27th August, 1940, last at the University College of Science, Calcutta.

The telegram had to pass through proper official channels before the necessary action could be taken but meanwhile the forest was ruined. When, however, the telegram had passed through the proper channels and reached the hands of the official concerned, after a month's lapse of time, the officer was quite active and replied by wire, "Fire-brigade is ordered to extinguish the fire".

The war has certainly made some change for the better and things are moving a little more rapidly. It must be said to the credit of the Hon'ble the Commerce Member that he brought into being the Board of Scientific and Industrial Research as quickly and without as little delay as possible with the result that our third meeting is going to take place on the 9th of September at Bombay. One or two things are already being manufactured on a large scale as a result of impetus given by some members of this Board. Different research committees have met, and the Technical Secretary is busy day and night toiling at the reports submitted by them. Over 80 workers are shortly going to be engaged on the research programme to be carried out under the auspices of the Board. This is a good augury and we hope the Board in which your Association has taken so much interest will score further successes, and that the present enthusiasm will continue and some real and tangible result will come out of all this.

I now refer to your task of educating public opinion. The interest of the public in science can be aroused only if the scientist comes down from his heaven of wisdom to the earth of the common man. I must confess that although we have scientists who can solve the most difficult mathematical problems and enunciate theories which will require days for even a man of science to understand, yet there are rather few amongst us who are able to do things which inspire the interest of the common man. When I was a young lad, the thing that made me most interested in science was the railway engine which I saw running up and down everyday from the residence of my uncle, who was

an officer in the railway department. My mother, my sisters, and my young relations knew of science not from discourses of learned men or from academic journals, but from the rapidly moving engines running to and fro and carrying heavy loads. The wonderful inventions of science such as radio, telephone, telegraph, railway engine and motor car have done more to arouse the interest of the common man in science than all the wisdom poured out by our men of science. Applied sciences have been rather neglected by our universities, and it is only during the last few years that interest in applied science has acquired the importance it deserves. The result has been that while we have a number of very distinguished scientific men, there are comparatively few scientific processes named after Indians, comparatively few machines which we can claim as our inventions and still less number of articles of utility which are in use which can be said to have been manufactured by us. That is why the common man calls us by the name of mere philosophers, mathematical dreamers and armchair workers etc. It is interesting to note however that this distinction between the pure and applied sciences is fast disappearing. Prof. Saha, who is well-known as a mathematical physicist, is now thinking of manufacturing compressor and vacuum pumps in his laboratory. We know that other scientific workers who were formerly more interested in producing theses and papers are devoting at least a part of their attention to the things that matter to the common man. If this attitude continues, I have no doubt that the common man will be able to take more interest in us, and the apathy of the man of wealth to science will shortly disappear.

You are lucky in having Dr Law as the President of your Association. He represents a rare combination of culture, science and industry. If you wish to make your Association a living force, and if you wish to be of real service to the public you shall have to cater for the public, produce scientific work which will help in the amelioration of the miseries of the poor people, which will do something to save our civilisation. It should help in providing better houses, better food, better living conditions, so that the legislators might be able to say that it is good that the scientific men are also engaging themselves in doing the task which so far constituted only their responsibility. The Indian Science News Association has done much good by focussing public attention on scientific problems. Besides the advocacy for the establishment of the

Board of Scientific and Industrial Research, I have seen "SCIENCE AND CULTURE" advocating the creation of the River Physics Laboratory in this province, the creation of a National Physical and Chemical Laboratory and an Institute for Fuel Technology, a Jute Research Institute and so forth.

This organ has fought hard for all that is good for us. This journal has been no respecter of persons or departments and has fought its battles independently and courageously. When the Board of Scientific and Industrial Research was created, the inadequacy of the measure and the vagueness of description regarding my own duties in the Government Communiqué excited the attention of the editors. When, however, it came to be known that I had already postulated with the Government that my duties will not be only advisory, but that I shall be actually in a laboratory connected with research, a letter of congratulations was promptly sent to the Government on this decision. It is this frankness and justness of criticism which I admire. I hope this spirit will continue and that the criticism of national affairs in the columns of SCIENCE AND CULTURE will be just and fearless.

Returning to the question of service which we can render to society, we must help the businessman in this country to bring about the industrialisation of our land. Although businessmen in this country like those in other countries are interested in gambling at the stock exchange, they do not like to take the risk on a gamble with the applied scientist. If they risk even one tenth of their wealth on experiments with industries, they will not only enrich themselves but will also bring untold wealth to their country and thus help the cause of humanity and science. It is to be hoped that the efforts of the Indian Science News Association will bring about this very important liaison between the industrialists and the workers in the scientific fields.

Before I sit down, I wish to say something which may look superfluous and even common place. As there is need for unity amongst the politicians, so is the need for unity amongst the scientific men. There is no organisation that is set up in this country which is not immediately criticised by a set of people. I am not referring to the old controversy of the Academies, of the *Current Science* or the *Science and Culture*. I am referring to the task before the

country, namely the industrial development of the country, particularly at the time when the scientific men are being given an opportunity to come to the aid of our industries. We should sink our differences of caste, creed and provinces and face the task with wisdom and courage so characteristic of the scientific man.

I have spoken enough on the working of the B. S. I. R. and the duties of this Association. The B. S. I. R. has been created during this period of stress and strife created by the European war and I must emphasise that the scientific men have to play a very important part. Supplies of trained experts will have to be more and more the concern

of the universities. In the speeches delivered by Mr Churchill and Lord Linlithgow it has been clearly indicated that India is going to be the centre of supplies for Europe and the Middle East. It is announced this morning that Sir Alexander Roger is coming out on a mission to organise the supplies and munition production capacities of our country. This is a step in the right direction. I am sure the scientific men present here and the readers of the journal will have opportunities to be able to contribute to the progress of this country. Let me hope that Indian science will not miss the opportunity and prove equal to the great task imposed upon it by the war.

SPIDER IS WORLD'S CHAMPION DIVER

The world's champion diver, according to an article in the magazine *Natural History*, is the water spider, the female of which can stay under water for hours and days and even sleeps and raises her young below water.

She accomplishes this almost unbelievable feat by spinning a broad airproof web or sac which she fastens between the stems of under-water plants. Then stretching the credulity of man even further, she fills it with fresh air by carrying down air bubbles from the surface and releasing them in her submarine chamber. And in this hideaway she lives a leisurely life secure from intruders, travelling to the surface for more air when the need arises. This remarkable water spider has even figured out a way to hang the eggs of her young conveniently from the filmy ceiling of her magic diving web.

The Work Before Indian Scientists

OUR thoughts* today are centred on the war and the international situation. The entire world is now passing through the throes of a new birth, and our lives, institutions, and destinies, to all appearance, have been thrown into the melting pot. Whether we are scientists, literary men, political workers, or just common men, we cannot leave this fact out of the reckoning.

So far as the scientists of Europe are concerned, the war has seen the most thoroughgoing harnessing of all their activities to the war machine. In India, however, their lives and activities have not yet been visibly affected by it, although signs are fast appearing that they will be. In the process of mobilisation of the resources of the British Empire for the prosecution of the war, demands are being made on an ever-increasing scale on the resources of India, both material and human, actual and potential. It seems as if the present war is going to stimulate the industrial revolution in India to a far greater degree than even the last one. Industries and lines of manufacture which in ordinary circumstances would not have had an immediate start in this country are being contemplated. There is already a scheme to establish an aeroplane factory and a ship-building yard in India, while heavy industries which were not making very great headway are being expanded and remodelled. Indians are also being recruited to the technical branches of the defence services, for work on the ground, on the sea and in the air. There is every likelihood that if the war lasts a few years more, it will see the industrialization of India taken to a point far in advance of the stage at which it stood at its commencement.

This is a development which is bound to affect Indian scientists and science. The trend is already in operation. Indian scientists are being requisitioned by the Government for giving the benefit of their experience and knowledge to the schemes

designed to secure the expansion of Indian industries. The Government of India has constituted a Board of Scientific and Industrial Research, whose functions are to advise the Government as to the lines on which industrial research should be conducted and the channels into which it should be guided in order to ensure the co-ordinated development of India's industries, as also to recommend specific problems for investigation to the staff under the Board and to the various scientific institutions of this country. This Board counts among its members some members of our Association, and its Director is Dr Bhatnagar, our honoured guest today. I have no doubt that this Board will pave the way for an intimate co-operation between our scientists and our industries. The development which it foreshadows is bound to grow and have a profound influence on our industrial future.

The scientists of India, and more particularly the members of our Association, on their part, have no reason but to welcome this development. If the articles and discussions which are being published in the organ of our Association furnish any indication, the industrialization of India is a cause very near to their heart and one in whose promotion they and the Association are actively engaged and interested. Almost every aspect of the industrialization of India, particularly in its scientific bearings, has received attention in our journal. The journal has touched upon problems connected with electrification, irrigation, health, agriculture and a host of other subjects. By so doing it has served to awaken its readers to the importance of these problems, and has brought the relevant facts and arguments before their minds; furthermore, it will, as I hope, make a valuable contribution to their solution on scientific lines.

There can be no doubt that this work is vitally related to the purpose for which our Association exists, inasmuch as the popularization of science as a technique of living and its presentation as a philosophy of life are complementary aspects of the great object of our Association. Obviously, the practical importance of science as an instrument of

* Adapted from the Presidential Address delivered by Dr S. C. Law at the fifth annual meeting of the Indian Science News Association held on the 27th August, 1940, last at the University College of Science, Calcutta.

industrialization and economic reconstruction requires far less stressing than its more intangible values. The proof of the pudding is in the eating, and the best advertisement of science is the actual demonstration of the power of science that people see in the numerous scientific devices which touch their lives at every point. Yet it may be doubted whether, for all the popularity of motorcars and radios, and all the new enthusiasm of Indian business men for new plants and machines, there is full comprehension of the real implications of these contrivances which are being used to a greater and greater extent by us. We seem as yet to have an imperfect realization of the sweep and meaning of modern science and of the revolution it is going to bring about in our social, economic, and political existence. We are even now too prone to misunderstand modern science as it has been developing since the end of the 18th century.

This misunderstanding must be removed. Modern science is not just an additional gloss on the existing and traditional scheme of things, it is a new phenomenon such as has not been seen in human society since the discovery of agriculture thousands of years ago. It has brought to man a new and vast power over nature, and is bringing into existence a new technique of living whose full shape we have yet to see. But already science has given sufficient proof to us that it is not a thing whose acceptance or rejection admits of a choice or a thing of which we can accept one feature and leave aside others. We have to take it as a whole, just as it is, on its own terms.

I am emphasizing the all-embracing and revolutionary character of modern science and urging a more positive approach to it for the simple reason that without realizing the one and adopting the other, there can be no planned scientific economy for India. It is of course true that science and the industrial revolution are making steady inroads into every walk of our national life and bringing about a dissolution of our old social and economic structure. But the whole movement is still uncontrolled and piecemeal. Too much is being left to chance and to individual likes and dislikes. We are not yet the master of the movement, which we must be, if we want to reap its full benefit. We must be more deliberate in our acceptance of science; we must plan its application as a whole and on a co-ordinated plan. Only this will enable us to complete the industrialization of India and the modernization of its means of production in the most effective way and in the shortest possible time. It will also spare us

the disturbance of equilibrium and lop-sidedness inseparably connected with haphazard processes. By accepting a conscious plan, based on a scientific outlook and scientific knowledge, we shall be able to bring about the transition from old to the new order with the least disturbance of our social equilibrium.

This means that the scientists of India must become ever-increasingly conscious of the part they must play in the economic transformation of India and be ready to undertake the burden in an ever-increasing measure. In this process the role of an association like ours is also clearly chalked out, and that role will be no minor one. I would say that the hopes of establishing a scientific economic order in India rests equally on actual scientific work, and on the dissemination of scientific information and ideas among the mass of the people. If the scientists will furnish the knowledge and technique which will make national planning on an adequate scale possible, the popularizers will create the fulcrum of public opinion without which the knowledge and technique of the scientists must be largely unavailing. As yet we suffer from insufficient co-ordination between these two wings. There is not perhaps in these days in India any serious dearth of competent scientists who could be set to the task of national planning, and such dearth which might still exist is likely to be removed in the near future. But the other half of the job, *viz.*, the mobilization of public opinion on behalf of a planned scientific economy, remains unaccomplished. This task must be shouldered by us.

Our Association exists for facilitating this work and is in fact giving more and more attention to this subject. This good work must be kept up. I have every confidence that Indian scientists as a class will never allow their enthusiasm in this matter to flag. There are among them men who are not only distinguished specialists in their own subjects but who are also patriots. They are awake to the wider social background of their work and to their duty to society. The thoughts and activities of these men have turned towards the problem of applying science on the widest possible basis for the national regeneration of India, and of awakening the public to its importance. Their example is inspiring. Let us also pray that their teachings and work may achieve their true and ultimate purpose by bringing into existence at no distant date a new order in India.

Long-Distance Radio Communication— Application of Records kept at Ionospheric Observatories

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INTRODUCTION

RADIO listeners are now so used to short waves, when tuning their sets to foreign stations, that they can hardly be persuaded to believe that, about a couple of decades ago, the use of such waves was quite unknown for long distance radio communication. The remarkable property of short waves for reaching long distances was accidentally discovered by amateurs, and attracted the attention of radio engineers only at the beginning of the last decade. Before that date, long-distance radio communication was synonymous with the use of enormously long waves. Wavelengths as long as 20 kilometres were in common use. Such long waves required, for their efficient radiation, the erection of huge aerial systems and employment of enormous power. The advent of short waves changed the situation completely. The aerials of a modern trans-continental short wave station would seem amateurish if compared to the elaborate aerial system of the old days. The power employed also is only a mere fraction of that necessary for long wave stations. Besides, short waves provide "room" for an immensely greater number of communication channels than the long waves. For these reasons, short wave has gradually supplanted long waves though it has also certain disadvantages. Firstly, short wave signal is subject to very strong fading. This, however, is not a very serious drawback and can be remedied by the use of devices like automatic volume control or by suitable disposition of the receiving aerial system as is employed in the so-called 'diversity reception'. It has another drawback which is more serious. Short wave signal strength is greatly dependent on the particular wavelength used and on the hour of the day and on the season of the year. In fact, for the maintenance of communications, different wave-lengths have to be used at different hours of the day, in different seasons

and also in different epochs of the sunspot cycle. Still as mentioned above, the difference in cost of erection and maintenance between a short wave and a long wave station is so great that in spite of these disadvantages and also because short wave provides greater number of communication channels, it is now universally used for long-distance radio communications.

It is obvious that to make the best use of short waves, the right wavelength has to be chosen at the right time. Here, the radio engineer is faced with a problem which he had hitherto been solving only by clever guess work based on long experience. It is the purpose of this article to describe a method by which it has been possible in recent years, to determine the most effective wavelength in a scientific way by utilising the collected data of the electrical properties of the upper atmosphere.

RÔLE OF THE IONOSPHERE IN LONG-DISTANCE TRANSMISSION

The different ionospheric regions which guide radio waves round the curved surface of the earth are represented in Fig. 1 which is for a typical summer daytime condition. For simplicity, the three regions, E, F₁ and F₂, are shown as three mere lines. Actually the regions have a certain thickness and the distribution of ionization density with height is roughly illustrated at the right of the diagram. The dotted lines show two of the many possible paths along which radio waves sent out from the transmitter T travel to the receivers at R₁ and R₂ by being reflected from the ionosphere at I₁ and I₂ respectively. The third dotted line indicates that waves sent out in this direction are not reflected and thus escape to the high atmosphere. This picture, simple as it is,

represents the basic mechanism of radio wave transmission over long distances. In actual practice the phenomenon is more complicated since the density of ionization and the heights of the ionized regions vary with time and geographical location of the place under consideration.

and are returned so by reflection. In the case of long distance transmission however, the wave is incident *obliquely* on the ionized strata and it is extremely difficult and tedious to obtain transmission characteristics at oblique incidence from experimental observations. The problem therefore is how

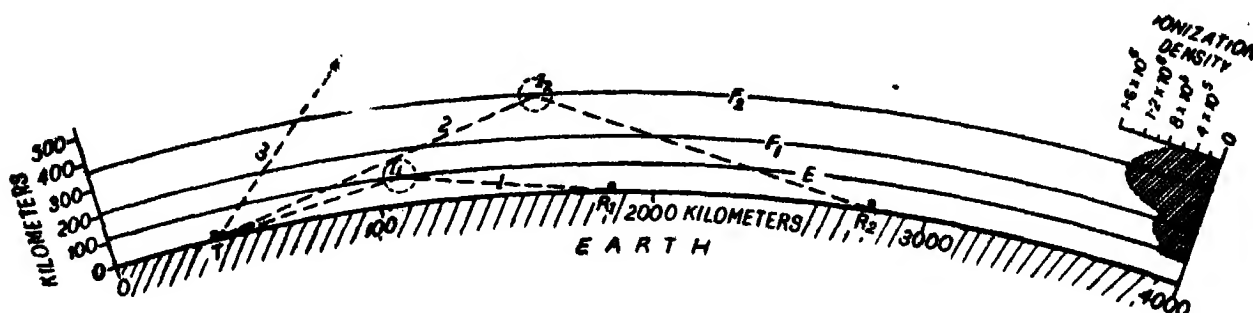


FIG. 1. Illustrating the mechanism of long-distance radio transmission via the ionosphere.

It is easy to see that the characteristics of the ionosphere at I_1 controls the propagation of radio waves from T to R_1 . These characteristics are the "height" and the ionization density of the region concerned. Before proceeding further, it is necessary to define the sense in which the term "height" is used. The actual path followed by a radio wave returned from the ionosphere is shown in Fig. 2. The usual method of ionospheric measurements gives the height z_v of the apex E from the ground. This height, as may be seen from the figure, is greater than the true height attained by the radio wave and is called the *virtual* or *equivalent* height of the region.

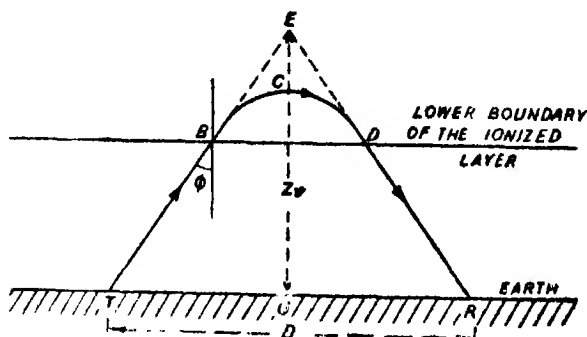


FIG. 2. Illustrating the actual path followed by a radio wave from the transmitter T to the receiver R. The virtual height of reflection EG is greater than the true height CG.

Now, the ionospheric observatories distributed in different parts of the world, keep records of ionospheric characteristics corresponding only to the case of *vertical* propagation i.e., for radio waves which are incident on the ionized strata *normally*

to utilize the observatory data obtained with *normal* incidence for computing transmission characteristics at *oblique* incidence.

CHARACTERISTICS FOR VERTICAL PROPAGATION

Records kept at ionospheric observatories supply the following data: (i) the virtual heights of reflection (z_v) at normal incidence for waves of frequencies that may be reflected and (ii) the critical frequencies f_E , f_{F_1} and f_{F_2} i.e., the maximum frequencies beyond which at normal incidence, waves cease to be reflected from the ionized regions E, F_1 and F_2 respectively. Fig. 3 depicts a typical record for a summer day, showing the variation of virtual

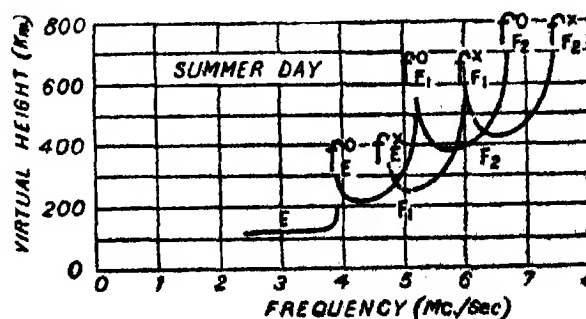


FIG. 3. Depicting a typical ($P'-f$) record made at ionospheric observatories.

height with the exploring wave-frequency. It will be noticed that there are a number of discontinuities in the curves. These discontinuities mark the *critical frequencies* i.e., the frequencies just above which the wave penetrates a particular ionospheric

stratum and begins to be reflected from the higher one. It will also be noticed that just before penetration, the virtual height of the stratum concerned increases enormously and more or less suddenly with the increase of wave-frequency. The increase is due to the fact that for frequencies near the critical one, the waves travel in the ionized region with a velocity much smaller than their normal velocity, which, of course, is the velocity of light. The waves therefore take much longer time to reach the receiver and appear to have been reflected from a very much higher level. It will be further seen from the curves that for a particular region, Region E say, there are two critical frequencies marked as f_{E1}^0 and f_{E2}^0 . This indicates that due to the earth's magnetic field, the ionosphere becomes a doubly-refracting medium and consequently, a radio wave, on entering into such a medium is split up into component waves which are reflected from different levels. One component marked 'O' is called the ordinary wave and the other marked 'X', the extraordinary. It should be noted here that the critical frequency is a measure of the maximum ionization density of the region concerned and of the two, any one may be used for calculating it with the help of the corresponding formula.

CHARACTERISTICS FOR OBLIQUE PROPAGATION

We have already seen that long-distance transmission corresponds to the case of oblique propagation through the ionosphere (Fig. 1). It can be shown that for a particular frequency, a wave, incident obliquely, is reflected from a lower level (that is, a level of smaller ionization density) than the same wave incident normally. Again the larger the angle of incidence (angle of wave path with the vertical), i.e., the greater the transmission distance, the higher is the upper limit of frequency of waves that can be reflected from a region of given ionization density. This upper limit of frequency for transmission over a given distance and time is called the *maximum usable frequency*. It is easily seen that the distance for which a given frequency is the maximum usable frequency is also the minimum distance over which signals of that frequency can be received. This minimum distance for any frequency is called the *Skip distance*; at any smaller distance, reception is impossible on that or any higher frequency.

CALCULATION OF THE MAXIMUM USABLE FREQUENCY

Data for normal incidence as kept at the ionospheric observatories can be utilised for computing the characteristics for oblique propagation in the following way.

It can be shown that if the earth be assumed to be flat, the maximum usable frequency f' for transmission over a distance D is given by

$$f' = f \sec. \phi,$$

where f is the critical frequency of the region concerned, and ϕ , the angle of incidence, is given by $\tan \phi = D/2z$. The above simple relation is found to hold good for transmission over distances up to about 500 kilometres. For long distances the curvature of the earth has to be taken into account and the analysis then becomes complicated. Without going into the details of the analysis, we may state here that the effect of the earth's curvature is to cause the radio wave to be reflected from a region of smaller electron density than would be necessary if the earth were flat.

For rapid analysis it has been found possible to determine approximate conversion factors. The maximum usable frequency is obtained by multiplying the critical frequency by the appropriate factor for the given distance and time. These factors depend upon the time of the day and the season of the year, and their values for transmission via different ionospheric regions and over different distances are given in the table below. The values are for single-hop transmission.

TYPICAL AVERAGE VALUES OF THE MAXIMUM USABLE FREQUENCY FACTORS

		TRANSMISSION DISTANCE (IN KILOMETRES)				
		500	1000	1500	2500	3500
<i>Winter</i>						
Midnight F	...	1.2	1.5	1.8	2.8	2.9
Noon F ₂	...	1.2	1.6	2.1	2.9	3.4
<i>Summer</i>						
Midnight F	...	1.2	1.4	1.7	2.4	2.8
Noon F ₂	...	1.2	1.5	1.8	2.5	2.9
Noon F ₁	...	1.3	2.0	2.7	3.6	...
Noon E	...	2.0	3.4	4.4	...	...

It will be seen that there are some blanks in the table. This is due to the fact that for the larger distances single-hop transmission is not possible.

The above conversion factors are for the latitude of Washington. These, together with similar factors for stations situated at other latitudes, may be used for determining the factors for places where there is no ionospheric observatory. It should be mentioned that in the tropical and sub-tropical regions, the factors do not vary appreciably for small changes in latitude. Finally, for a particular latitude the ionospheric characteristics are essentially the same throughout at the same local time.

Curves in Fig. 4 (b) and 4 (c) show the relations between the three variables—maximum usable

and it is desired to determine the optimum frequency for communicating with a mobile unit at a given time.

PRACTICAL APPLICATION OF MAXIMUM USABLE FREQUENCY DATA IN RADIO COMMUNICATION

We may now discuss the method of utilising the above data for practical purposes. The problem with which a radio engineer is concerned is this: Given the two points between which communication is to be maintained, the approximate hours of trans-

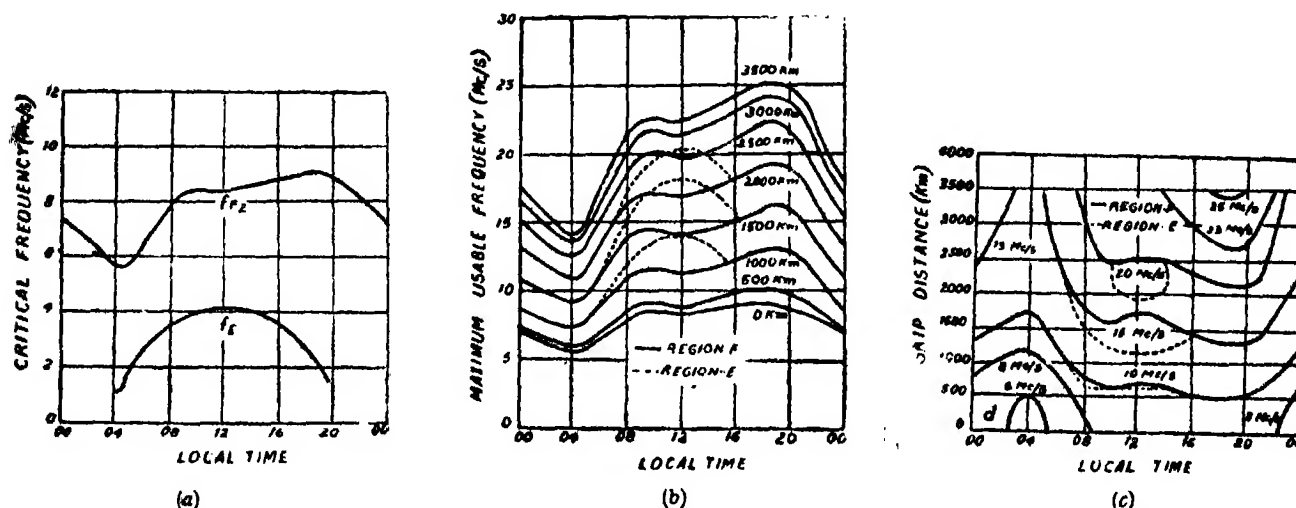


FIG. 4. Illustrating the methods of plotting the maximum usable frequency data. The close resemblance between the monthly average critical frequency curves in (a) and the maximum usable frequency curves in (b) is to be marked.

frequency, distance of transmission and time of the day—necessary in communication problems. Curves in Fig. 4 (a) depict the corresponding monthly average critical frequencies for Washington, D.C. at different hours of the day during June, 1937.

Of the two sets of curves shown in the figures, the one depicting the variation of the maximum usable frequency with local time for different distances as in Fig. 4 (b) contains the available data most concisely and completely and is in a form for ready use. Now, in the case of fixed stations the distance of transmission is fixed and only a certain number of frequencies is licensed for use. The optimum frequencies from amongst these to be used during different hours, or the optimum hours for any of these frequencies can be easily determined with the help of these curves.

The set of curves in Fig. 4 (c), showing the skip distance-time curves, is particularly useful for mobile radio service where the distance varies continuously

mission and the allowed frequencies; it is required to find out the optimum frequency which may be employed for maintaining the communication.

The first information which is necessary is that regarding the nature of the transmission path, i.e., whether the path is single-hop or multi-hop. The maximum range for single-hop transmission is obtained when the angle of departure above the horizontal is zero. The distance covered by such a hop is about 2400 km. for transmission via Region E and about 3500 to 4500 km. for that via Region F. In practice, it is found that transmissions at angles of departure less than $3\frac{1}{2}^\circ$ do not result in efficient communication due to ground absorption of the high frequencies used. Corresponding to this angle of departure, the maximum range is less, being 1700 km. for transmission via Region E and 3000 to 3500 km. for that via Region F. It is obvious that for distances greater than these ranges the transmission path should be multi-hop. In the case of

single-hop transmission, the part of the ionosphere which controls the transmission lies half-way between the transmitter and the receiver. For the case of multi-hop transmission, the corresponding controlling regions are easily determined. For the latter however the different controlling regions might be in different latitudes and in different conditions of daylight or darkness. There will thus be different maximum usable frequencies for different hops.

Knowing the nature of the transmission path, curves of the type given in Fig. 4 can be employed for determining the maximum usable frequency for a given transmission path and time. For the case of multi-hop transmission the maximum usable frequency which is the lowest will have to be taken.

OPTIMUM FREQUENCY—DELHI-CALCUTTA SERVICE

The optimum frequency, which must be below the maximum usable frequencies, is now chosen from the available frequency range. For this, two facts have to be considered. Firstly, the absorption of radio waves in their passage through the ionosphere increases *i.e.*, the signal strength becomes less, as the transmission frequency is lowered below the maximum usable frequency. Secondly, for maintenance of communication, it is necessary in practice to allow for the day to day variation of critical frequency from the monthly average value. Experimental results over long periods show that this variation is within 15% of the monthly average value.

Now, it is not ordinarily possible to change the transmission frequency frequently and hence a small limited number of frequencies is so chosen that a fairly efficient communication at all hours of the day may be provided. The general rule is to select a frequency lying between 50% and 85% of the monthly average maximum usable frequency for a given distance and time. Because, below 50%, the received signal may be weakened by absorption and above 85%, the frequency may, on some days, be beyond the maximum usable frequency on account of the day to day variation of ionospheric conditions.

In order to understand the procedure adopted for calculating the working frequencies for a given transmission distance let us for example, take the case of transmission between Calcutta and Delhi. The distance between these two places is 1295 kilo-

metres and hence the transmission will be a single-hop one. The midpoint of the path, where reflection takes place, is near Jaunpur (Lat. $25^{\circ} 40' N$; Long. $82^{\circ} 57' 38'' E$) in the United Provinces. The properties of the ionosphere at this place determines the transmission characteristics between Calcutta and Delhi. Since the latitude of the place is only little different from that of Calcutta, the ionospheric characteristics at the mid-point may be taken to be the same as those at Calcutta. Fig. 5 depicts the

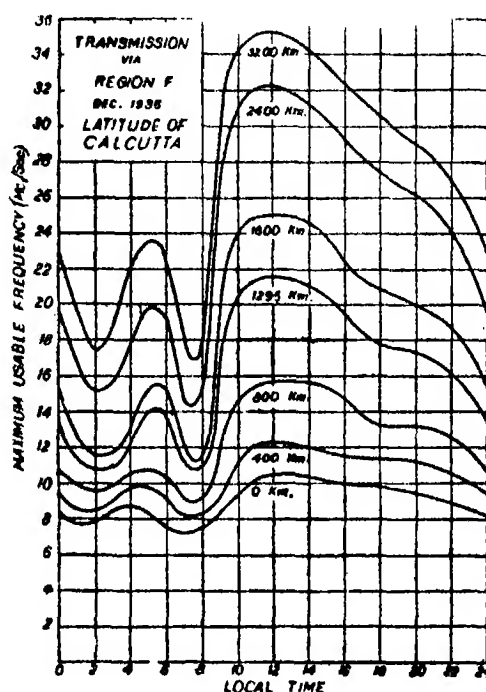


FIG. 5. Depicting the maximum usable frequency *versus* local time curves for Calcutta for December, 1936.

variation of maximum usable frequency with local time for different transmission distances. The curve corresponding to zero kilometre gives the monthly average critical frequency for Region F obtained at Calcutta in December, 1936. Now, since the local time at the point of reflection is only 2 minutes in advance of Indian standard time, the abscissa of Fig. 5 though plotted as local time, gives practically the I.S.T. Fig. 6 shows such a curve for the given transmission distance of 1295 km. Two auxiliary curves (dashed ones) have been drawn on the same graph, one 15% and the other 50% below the maximum usable frequency curve. The frequencies chosen for transmission should lie between these two curves and should also be such as to involve as few

changes of frequency as possible during a day. The dotted lines show one possible set of frequencies

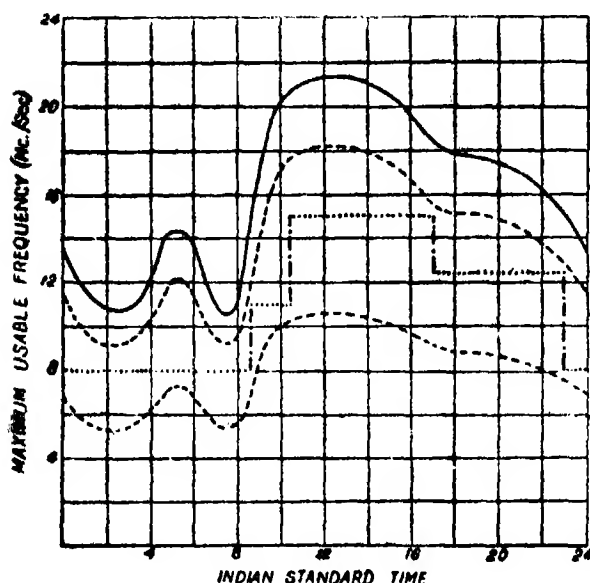


FIG. 6. Illustrating the method of determining the optimum frequencies to be used for transmission over a given distance. The curves are for transmission between Delhi and Calcutta.

which may be used for transmission between Calcutta and Delhi. The vertical dot-dashed lines mark the hours at which the transmission frequency is to be changed.

The National Bureau of Standards of the U. S. A. is using this method with considerable success, for computing the optimum frequency and publishes monthly charts depicting the frequencies to be used at different hours of the day and for different ranges, based on ionospheric data recorded at Washington. The importance of such publications is evident and a preliminary attempt has therefore been made in this article to prepare similar charts for the sub-tropical latitude of India (Fig. 5). Unfortunately, though the equipments necessary for keeping 24-hourly records are available at the laboratory in which the author works, it is not possible to keep such records over long periods for lack of funds.*

* The author has much pleasure in acknowledging with thanks the help he received from Prof. S. K. Mitra in the preparation of the article.

BEETLES AS BONE CLEANERS

An army of beetles has been mustered into the service of cleaning bones of small animals that are to be mounted, because the beetles do the job better and quicker than humans. Skeletons and skulls of animals are shipped to the American Museum of Natural History from points as far distant as Persia and Australia, and invariably there are scraps of dried meat clinging to them which must be removed before mounting. The collection of bones is placed in a metal-lined "arena", where they are attacked by hundreds of beetle cleaners. The insects are of a variety propagated from stock received from Africa and Asia.

The Santal Tree-Press and Plank-Press

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IN an earlier paper I have described the tree-press of Nicobar and of Assam ; and in a post-script to that paper, I mentioned that the Santals are stated to have formerly used a similar press for oil making.¹ My enquiries in Santal Parganas proper regarding a tree-press did not lead to the discovery of any actual specimen. I was however informed in some of the villages that tree-presses had been known to have existed formerly. Thus Babulal, the head man of Amui, in Jamtara subdivision of the Santal Parganas, a man about 35 years of age said that he had heard of this press but never seen a specimen. His uncle (a step brother of his deceased father) Kandon, an old man over 60 years of age (computed on the basis of age of grand-children, and other statements) stated that he had seen the tree-press when he was a young lad. There was then a tree-press in Amui, and another in a village on the other side of the Ajoy river. He said that a stone was placed at the base of a *Mohua* tree, a hollow was made in its trunk and a thick plank about a foot and a half long (he said a cubit, which is of this size) was placed on the bundles of crushed and steamed mohul seed. Another plank, a little longer, was placed on the stone but under the bundles. A log was then inserted into the hollow, and pressure applied by means of a thong or rope tied to the log, and the lower plank. He gave a demonstration of how he had seen the press worked. He could not say who introduced the plank-press (*Sunum pāta*). But he stated that people found it safer to work the plank-press and therefore abandoned the tree-press. In the Jhargram subdivision of Midnapore I was informed that the tree-press had been in use about a generation ago. A Santal young man of age not more than 25 years, of the village Kalabuni, about three miles from Jhargram railway station showed

me in this village where there was now the usual *Sunum pāta* or horizontal plank-press. There was a *Mohua* (*Bassia latifolia*) tree which had formerly been used for a tree-press. He said he had seen it worked when a boy. There had been a big hole (now a hollow) in the side of the tree and a block of wood or stone used to be put at the base. Baskets of steamed and crushed *Mohua* seed were placed on the block and pressure was applied on these by a log thrust into the hole in the tree. His statements were confirmed by the village elders independently. In village Kasia, I was shown a *terel* or *keond* (*Diospyros melanoxylon*) tree formerly used for a press. It is now known as the *cunruj pāta terel*, i.e., the *terel* tree used for an oil press. There is now a *sunum pāta* here ; the tree-press disappeared over a generation ago. Only old men remembered having seen it in operation.

In Mayurbhanj, where I went during Christmas holidays in 1938 for field work, enquiries made of the Santals at a weekly fair led to the discovery of a tree-press in the village Rokoni, in Muruda Pargana. The village is about 22 miles to the east of Baripada, the capital of Mayurbhanj. The village has several hamlets, one of which Patiasahi is inhabited entirely by the Santals. In this hamlet I came across a plank-press of the usual type and also found the tree-press. The plank-press was found in several other villages near by, and not always in Santal houses. In Rokoni itself, in the main village, which is inhabited by potters mostly, I found a plank-press in the house of Judhisthir Behara, a potter by caste. The Oriyas call it the *Jānta* or press. The tree-press was subsequently found in almost every Santal village in this part of the country.

The plank-press is invariably owned by an individual ; but he allows his neighbours (co-villagers) to use it, for a consideration. Generally, one *poa* (quarter seer) of oil is made over to the owner for every five seers of oil pressed out. The tree-press in most villages was however stated to be the

¹ Indian oil presses and oil extraction : *Journal of the Indian Anthropological Institute*, Vol. 1, 1938, Calcutta.

There is a short note on the Santal tree-press in *A Santal Dictionary* by P. O. Bodding besides the mention of it in the footnote to the folk tales.

property of the entire Santal hamlet. The press in Rokoni (fig. 1 & fig. 2) consists of the following parts :—

- (1) The main tree trunk, of a thick living *Mohua* tree, with a hole in it, two feet from the ground level.
- (2) The block of wood fixed to the ground before the hole, and just below it. It is roughly shaped and flat on top. Size—4'-3" long, 1'-10" wide and 1' high. It has a circular groove on the outer half of the top surface about two inches wide and a foot in diameter. It ends in a lip at the edge of the block. In this lip is inserted a bamboo channel made by splitting into two a hollow bamboo a few inches long. The groove is known



FIG. 1.

as *cando* and the channel of bamboo as *luta*. The *luta* may also be of palm leaf.

- (3) The top plank. It is only a short oblong piece with two projecting handles. There are several such oblong planks about a foot long and ten inches wide. They are all termed *aphra*.
- (4) The presser. It is a long pole, being a slightly dressed trunk of a tree. One end is inserted into the hole of the big *Mohua* tree. Length, 13 feet. Diameter, 7 inches. Generally the length varies from 12' to 14' and the diameter from 6" to 7".
- (5) The press-lever. In this particular type of tree-press, the pressure is not applied directly but by means of a lever, which is another similar pole (trunk of a tree) fixed in a hole in another big tree in a direction at right angles to the presser described in the previous paragraph. Both the poles are known as *janta tãra*.

The tree-presses in the villages of Ajan, Sanniasi, Bahresahi and Camardonr (shown on survey maps as Bhaduasahi and Camardahani), while resembling this type in general outline varies in certain details.

In Bahresahi, Camardonr and Sanniasi, the fixed block at the base of the tree is of stone, with the usual groove and lip; at Ajan, the block is of wood as in Rokoni. In Bahresahi, the presser "p" (fig. 3)

rests on a forked upright "t" known as *Thesa Khunti* fixed in the ground near the end of the long pole, almost in a line with the hole and the stone. There is another upright log "k" known as *Khunti*, about two feet away to the side of this line (to the left, facing the tree). It has a pin, "h" *Khila*, at about a foot from the ground. The end of the press-lever is tied to the upright log (*Khunti*) and pin (*Khila*) and pressure is applied on the presser log, after taking the latter off the fork of the supporting



FIG. 2.

log (*Thesa Khunti*). Three or four men sit on the presser to apply the necessary force.

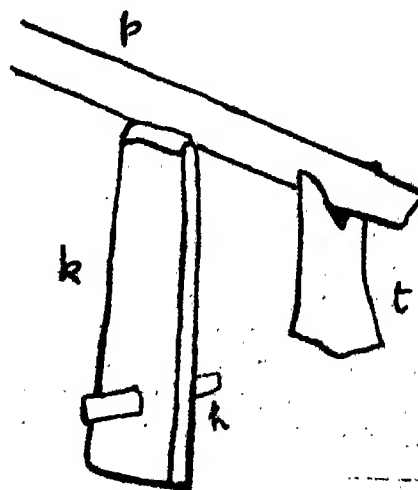


FIG. 3.

In the three other villages, two press-levers are employed. In Sanniasi there are two tree-presses at

two ends of the hamlet, and both are of this type. In one of these there are two upright logs for tying the ends of the press-levers with fibres or thongs, one on each side of the middle line, *i.e.*, the presser and a couple of feet away from it. (fig. 4).



FIG. 4.

In the other tree-press, in Sanniasi, a thick root of the main tree of the press is used to tie one of the press-levers, instead of fixing an upright log in the ground. In Camardonr and Ajan slots are cut in the uprights and (fig. 5) the press-lever ends inserted into them. Pressure is applied at the other ends of these levers by one or two men forcing them downwards.

The fork comes in handy for resting the presser in an elevated position, necessary for placing the bundles of seeds below its end near the tree. A tamarind tree was used for one of the presses in Sanniasi, and a banyan tree was so utilised in the main hamlet of Ajan. Elsewhere *Mohua* trees were utilised. None of these villages, except Rokoni had a plank-press.

The tree-press has also been reported from Singhbhum among the Santals. It is also stated to have been in use until recently in a village in the Noakhali district of Eastern Bengal among the Hindus living near the border of Hill Tipperah. It has also been noted in my previous paper that the tree-press is found in upper Assam. A photograph showing its use in the Darrang district among Koches, was reproduced in that paper. A description was also given of the tree-press used by the Nicobarese who speak a language

of the Austric group, intermediate in position to the languages of the Mundari and Monkh-Mer sub-groups.

The *Mohua* kernel, which seed alone is pressed by the Santals in these machines, is first of all crushed and then steamed. It is then packed in bundles of straw or in baskets termed *topa*, made in Mayurbhanj, of a creeper called by the local Santals *jāmlār*. The fibre is soft and strong; and woven into round flat baskets of a check pattern, of diameter $7\frac{1}{2}$ inches. The packed baskets are placed on the block of wood, on the *cando*, generally putting four to six baskets together one on top of the other. The top *āphrā* is now put on the baskets and the presser adjusted to the middle of the top plank. Where there is only one press-lever, it is now brought over the presser, and three or four men sit on this last pole. Elsewhere the press-levers are fixed and pushed downwards. The oil dribbles out by the channel and is caught in a pot placed in position. After the oil has come out as far as possible under such pressure,

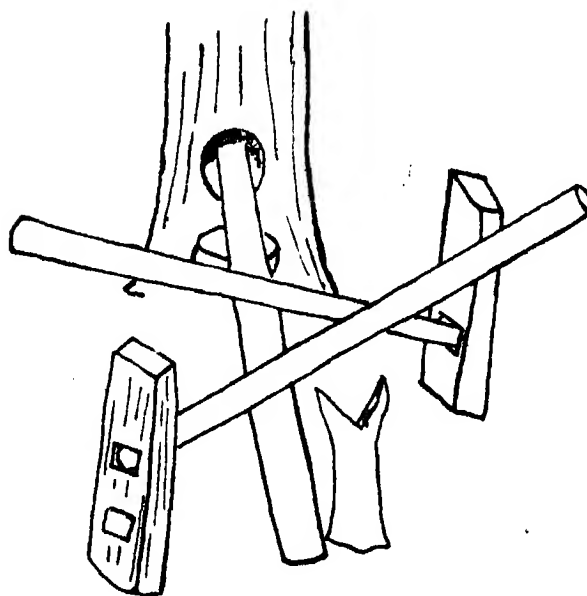


FIG. 5.

the presser and press-levers are raised, and two or more *āphrā* planks inserted between the top plank and the baskets. Pressure is then again applied and further oil drained out. The cake that remains over is used as fuel. The tree-press is termed *cunruj pata* to distinguish it from the ordinary plank-press, termed *sarpha pata*, in Mayurbhanj.

Mohua oil is used in cooking in this part of the country and is also used to lubricate cart wheels. The plank-press in the house of Mangat Manjhi, a Santal

of Patiasahi in Rokoni was being used to press out *Mohua* oil on a commercial basis when I with my students visited the village in 1938. The owner had engaged three other Santals to help him in this work. At that season, *Mohua* oil was being sold at five annas per seer. The hired men were getting as daily wages five seers of paddy, worth about an anna and a half. We could not find out how much time or labour was spent on collecting the kernels. But we were told that Mangat and his three men would press daily ten to fifteen seers of oil, worth from rupees three to rupees four nearly. If only two persons worked at it, apparently five seers or a little more of oil would be pressed out in a day. This would be the number that would usually work if a family wanted to press oil out of kernels collected by it, with occasional help from other members of the family. I saw a (Santal) husband and wife, helped by another member of the family working a plank-press of a non-Santal in the village of Baldia to press out oil for domestic use. They stated five seers to be the amount obtained in a day and this was confirmed by the owner of the press. For lending the oil-press for a day, the owner would therefore get oil worth one anna and a quarter or perhaps a little more—practically half a day's wage for an adult. The daily rate of the wages varies from two to three annas a day for an adult in this area.

The tree-press of the Santals in Mayurbhanj differs from the single lever tree-press of Assam and Nicobar in respect of the arrangement for applying pressure. As noted before, an additional lever is employed. In other words it is a double lever tree-press. A reference to my earlier paper will show that I suggested that the double lever plank-press had evolved from the single lever tree-press. The Santal double lever tree-press furnishes evidence of the correctness of this view by preserving an intermediate type. We may try to reconstruct the possible line of evolution from the Santal tree-press to the full-fledged plank-press. The second tree, for the insertion of the press-lever as found at Rokoni, is replaced in the type used at Bahresahi by an upright log. There are slots cut in the uprights at Camardonr and Ajan, comparable to the hole in the second tree, for insertion of the press-lever. The slots however have given way elsewhere to tying with thongs or ropes. We may therefore presume that in later types, the living tree into which the main lever (here termed presser) was thrust, was replaced by a fixed upright. The presser had its lower surface dressed to prevent slipping and was tied to the fixed upright. The fixed

lower wooden block (in place of stone) was extended and became the lower plank or log of the improved press, the *cando* remaining in the middle, and the channel for draining the oil naturally going to the side. The two uprights on the two sides would help to keep the two planks or logs of the press proper in position. The press-lever or levers would just be tied at one end, at the side and the force applied. The Seraikella oil press of first type (text figure 1, page 45 of my paper quoted) is an example of this kind of plank-press, with the planks vertical. It would be more likely that the forked upright which serves as a rest for the presser as noted before, will be used for tying the two planks together to keep them in position. This would make it more convenient to fit the press-levers in the loop of the thongs (or ropes) on the same side as each of the levers. I may add here that in Santal plank-presses two levers, one on each side of the planks, is also quite common.

The final improvement consisted in fitting the uprights at each end into the two planks or dressed logs, of the press instead of tying them. The press-lever continued to be tied to the upright, but the fulcrum of the lever was obtained by placing that end against the press as a whole for convenience.

The plank-press, as noted before, is not found in the purely Santal villages in Muruda Pargana. It is common in the villages where there is a hamlet of the Hindus, and is found also in the houses of the Hindus. It is found also among other people, as noted in my earlier paper. The Santals themselves admit that the plank-press has replaced the tree-press among them. In some villages in Jamtara, this happened two generations ago; in Jhargram it occurred in some areas a generation or two ago. But it has survived in other parts of the Santal country, like Singhbhum, and notably in Mayurbhanj. It shows that the plank-press had assumed its present form among non-Santals before it spread to the Santals although the tree-press furnished the basis of it. The geographical distribution of the tree-press itself is limited within the bounds of the area to which the Austric speaking tribes spread in India, (including Nicobar Islands) although in two of the places (in Assam and Bengal) where the tree-press is found, such tribes have now disappeared. There is however an island of Austric speaking people near by, in the Khasi hills. Language may have changed and racial absorption even may have occurred in both these places while leaving the particular element of material culture to survive because of its simplicity and utility.

Octane Number and Super-Fuel

N. K. SEN GUPTA

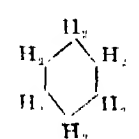

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SINCE the outbreak of the present war American scientific journals are writing ceaselessly that Germany has a very low stock of high-octane fuel, which is essential for aviation, and consequently is not in a position to continue the war for a long time. In the present article an attempt is made to explain what this high-octane fuel is and what bearing it has got on aviation.

In the early part of this century the naptha stripped from crude oil ("straight run") and recovered from natural gas was the only source of motor fuel. But it was discovered that the tendency of the fuel to "knock" restricted the power of the spark-ignition engines to convert the energy of the fuel into power. The thermal efficiency of an internal combustion engine is increased with increasing compression ratio, *i.e.*, for the same amount of fuel more energy is converted to power. Typical compression ratios of ordinary gasoline engines are near about 6:1. This means that the mixture of gasoline and air that is charged in the cylinder of the engine is compressed to one-sixth its volume before it is ignited by an electric spark. The products of combustion, being heated up to a high temperature by the heat of combustion of the fuel, develops a high pressure which forces the piston out and thereby converts the heat energy of the fuel to mechanical energy. With the "straight run" gasoline, if the compression ratio exceeds the value mentioned above the mixture of gasoline and air will not require a spark, but the heat generated due to compression only will raise the temperature so high that the mixture would start burning in the cylinder long before it should. The mixture would start burning while the piston is still compressing and thus cause a violent 'knock' or even force the piston back down the cylinder and cause the engine to start running backwards.

In order to have therefore more power from the fuel, the compression ratio of the engine should be

high and the fuels with higher anti-knock properties must be used. The anti-knocking property of the fuel is measured in terms of octane number. The octane number of a fuel is expressed as the per cent of iso-octane in a blend with *n*-heptane, which produces the same tendency as the fuel to knock in an internal combustion engine run under specified conditions. The octane-number of iso-octane (2,2,4-trimethylpentane) is 100 and that of *n*-heptane 0 by definition. How octane number varies with chemical structure for a given number of carbon atoms is brought out by the following tabulations:

	Approximate Octane Number	Approximate Octane Number
$C-C-C-C-C-C$	40	
$C-C-C-C-C=C$	80	
$C-C-C-C-C$ $|$ C	70	
$C-C-C-C-C$ $|$ C	80	
$C-C-C-C$ $|$ C$ $| C	120	
		
		80
		
		100

Several years ago, the General Motors Corporation of U. S. A. carried out researches to find out the relation between the octane number and compression ratio. The fuels used in each case were just capable of avoiding a knock. A car was run both on the dynamometer and on the road. It was found that 69 octane-fuel was required for standard 5.25 compression ratio, about 95 octane-number for 8.0 compression ratio, and something better than 100 octane-number for 10.3 compression ratio. At a speed of 40 miles per hour, the miles per gallon im-

proved from 12.5 at 5.25 compression ratio to 18 at 8.0 and 21 at 10.3. The average increase in economy, between 10 and 60 miles per hour, is about 45 per cent in going from 5.25 to 8.0 compression ratio under these conditions of constant performance.

The importance of high octane fuel in aviation lies in more mileage with less fuel. Figuratively an increase from 87 to 100 in octane-number allows a plane to carry 1200 lb. less fuel on a 1400 miles flight. Seven more passengers or an equivalent weight of mail or freight may also be carried instead. Present 100 octane-number aviation fuels have made possible a 15 to 30 per cent increase in power for take-off and climbing, or a 20 per cent reduction in fuel consumption during flight, when compared to a previously available fuel of 87 octane-number. 100-octane fuels have increased both power per cubic inch of displacement and power per gallon of fuel.

Before a gasoline is to be used in an internal combustion engine, two important properties—high lead susceptibility and high volatility—are to be ensured to approach an ideal condition. Lead susceptibility is the property of a hydrocarbon which may be measured by the increase in octane-number obtained by the addition of a given amount of tetraethyl lead $[Pb(C_2H_5)_4]$; therefore lead-susceptibility is the ability of a fuel to respond to "leading". This unique ability of tetraethyl lead to improve octane-number was discovered about 17 years ago. Addition of as small a quantity as 3 c.c. of tetraethyl lead per U. S. gallon increases the octane-number of iso-octane itself to about 114. In all cases the first addition of lead produces the most marked effect. Gasoline containing tetraethyl lead was first put on public sale in a single service station in U. S. A. in the year 1923, under the now familiar name of "ethyl" gasoline. Fourteen years later, in 1937 about 66 million pounds of tetraethyl lead were marketed, sufficient to increase the octane-number of 20 billion gallons of gasoline by some 6 or 7 points. In the aviation field almost all gasoline of 80 octane-number or better contains tetraethyl lead. In fact, the performance of the modern military and the transport planes is due in large part to the development of high octane gasoline, a development in which tetraethyl lead has played an important role.

When the octane-number is so important in preventing the knocking in high-compression engines then question may be asked why iso-octane itself or other high-octane ingredients are not used. Here the factor of volatility comes in. Gasoline must boil

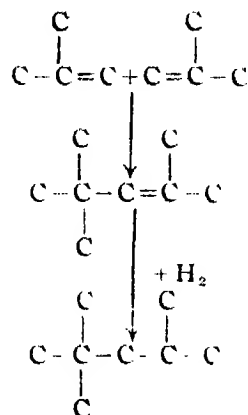
within a certain range of temperature, which varies somewhat with the grade of gasoline, its use, and the season of the year. Conventional aviation gasoline has an average boiling range of 180-210°F. Most desirable high-octane ingredients have a boiling point much higher than that (iso-octane—200-240°F.) and so must be diluted with more volatile, less knock-resistant hydrocarbons. This reduces the octane-number of the blend. The decrease in the octane-number of the blend is increased by tetraethyl lead.

Side by side with the development of tetraethyl lead, the petroleum refiners are also striving hard to produce gasoline having high volatility as well as high octane-number. Thermal cracking of crude petroleum was originally introduced to satisfy the rapidly increasing demand for gasoline without using up all available resources. But the cracking operation, whereby higher boiling petroleum fractions are broken down into materials boiling within the gasoline range, did more than increasing the gasoline volume. It has given the refiner considerably better control over his product, by which the branchiness, the unsaturation, and the aromaticity of gasoline can be increased, all of which make for higher octane number.

Next the process of destructive hydrogenation filled up the gap between the aromatic and aliphatic hydrocarbons and it has now become possible to go from one to the other. Operations at moderate temperatures in the presence of hydrogen, maintained at a pressure of several hundred atmospheres produces more gasoline from the crude than mere thermal cracking, and also removes the undesirable sulphur quantitatively. By means of operations at higher temperatures, extending for a longer time of contact than that of straight thermal cracking, it is possible to produce a material of high aromatic content. This type of hydrogenation has the additional advantage of producing high octane-number fuel in the higher boiling range.

The gasoline industry is now entering its fourth phase with the production of synthetic fuels. Gaseous hydrocarbons are also produced along with more gasoline from the process of thermal cracking. In addition to methane, these gases, include the two-, three-, and four-carbon hydrocarbons, and by suitable processes they are now being recombined to produce synthetic products having higher octane number and higher volatility. Polymerization of isobutylene in the liquid phase with sulphuric acid

produces 2,2,4-trimethyl pentenes which, on hydrogenation yield 2,2,4-trimethylpentane or iso-octane:



The above is the iso-octane used as a reference fuel for anti-knock evaluation. A few years ago the petroleum refiner had to buy it for evaluation purpose from the chemical manufacturer at about 70 rupees per gallon. Today it is being produced at a rate of million gallons per year for use in commercial aviation fuel. As will be recalled the octane-number of this product is 100 by definition.

Branched chains are also formed by direct additions of olefins to paraffins. This type of alkylation takes place with the aid of a modified Friedel-Crafts catalyst and even, in the absence of catalyst, at high temperature and pressure. Very recently a new compound called neohexane with a boiling point of 121°F. and with an octane number of 94 has been announced. The commercial process by which neohexane is being made is called "thermal alkylation". This is an alkylation reaction—the combination of an olefine with a paraffin. It is carried out at high temperature and high pressure in the presence of an excess of iso-butane. Neohexane has more lead susceptibility than iso-octane so that on "leading" it has an octane rating of 115-120. Even a blend

of 50-50 iso-octane and neohexane has more lead susceptibility. Therefore neohexane and iso-octane can be blended with other hydrocarbons to yield a blend in the right boiling range and with much higher octane-number than heretofore attainable.

This art of synthetic gasoline manufacture is being so much perfected that the petroleum chemists are thinking now of producing such hydrocarbons as tetramethylbutane and 2,2,3-trimethylbutane, which have octane ratings of at least 125. But is there any limit to this increasing trend towards higher and higher octane number and higher compression ratio? There appears to be a feeling in certain quarters that the ordinary automobile engine cannot utilize efficiently the fuels that will be appreciably higher in anti-knock value than those available today. In fact, testimony was recently presented to the Temporary National Economy Committee in Washington to the effect that the motor of today has reached the top in high compression ratio and therefore there is no need for further improving the quality of gasoline. But in the development of aviation, where power per cubic inch of displacement is usually more important than thermal efficiency, the situation is different. It has been demonstrated that a supercharged engine can utilize fuel of as high an anti-knock value as may be available. With the increase of intake manifold pressure for supercharging, the octane number of the fuel must also increase, if the knocking is to be prevented. An important advantage of supercharging is that for the same engine supercharged to 10 inches of mercury above atmospheric pressure, the horsepower ordinarily available in an unsupercharged condition rises to twice the original value. It may therefore be said that no limit can be now set as to the octane number of the fuel. The designers of the automobile engines of the future will alone decide whether they will be capable of utilizing the superfuel to be produced in days to come.

The Late Sir Joseph Thomson

WE regret to announce the passing away of Sir J. J. Thomson, O.M., F.R.S., Master of Trinity College, Cambridge and formerly Cavendish professor of experimental physics. His earthly remains have been interred in the Westminster Abbey by the side of his most brilliant pupil Lord Rutherford. He was the last of the line of British physicists like Kelvin, Stokes, Maxwell and Rayleigh, who received their early training in mathematical physics but later took up experimental research and who gave a characteristically British stamp to the development of physics in the latter half of the nineteenth century. We give below an account of his life and activities.

Joseph John Thomson was born on December 18, 1856 in Cheetham, a suburb of Manchester. He was intended to be apprenticed to an engineering firm. While on the waiting list a friend advised his father to have the boy, who was then only 14 years of age, admitted to the Owens College—which subsequently became the University of Manchester—for a course in engineering. His teachers were Osborne Reynolds in engineering, Balfour Stewart in physics, William Roscoe in chemistry, and Thomas Barker, a senior wrangler from Trinity College, Cambridge in mathematics. Amongst the friends he made at that time were Arthur Schuster and J. H. Poynting; the friendship with the latter, Thomson records to be one of the greatest joys of his life.

His father died soon after his admission to the Owens College, and as the family could not pay the heavy premium necessary for joining an engineering firm, it was decided to allow him to continue his studies in the Owens College, where he stayed for five years. Had it not been for the sacrifices made by his mother and the scholarships he won, it would not have been possible for him to continue his studies in Manchester and later in Cambridge. On the advice of his professor of mathematics, Professor Barker, he decided to appear at an entrance scholarship examination tenable at Trinity College, Cambridge. He was awarded a minor scholarship of value £75/- a year and a

subsizarship at Trinity College which he joined in October, 1876.

He began to read for the Mathematical Tripos, and as was the custom he attended the classes of the famous Cambridge coach Dr Routh, of whom he has given a very interesting account in his *Recollections*. He attended the lectures of Cayley, Adams and Stokes, also N. D. Niven's lectures on Maxwell's *Electricity and Magnetism*. He sat for the Mathematical Tripos in January, 1880, and came out as second wrangler, the senior wrangler of the year was Sir Joseph Larmor. It is interesting to record that Prof. Homersham Cox of Muir College, Allahabad was the fourth wrangler the same year. Thomson used to visit the Cavendish Laboratory during this period, but somehow he never met Maxwell who died in 1879. Later on Thomson edited the second edition of Maxwell's *Treatise on Electricity and Magnetism*, to which he added a supplementary volume entitled *Recent Researches in Electricity and Magnetism*.

Thomson had done a certain amount of experimental research work in Manchester, one of which ended in an explosion which injured his eye, and for sometime it was doubtful whether his eye could be saved. After taking his B.A. degree in 1880, till his obtaining the Cavendish professorship, his time was fully occupied with both theoretical and experimental investigations. For his Fellowship examination, for which a dissertation had to be submitted, he took up a subject the suggestion for which came to him in Manchester while attending Balfour Stewart's lectures on the Conservation of Energy. Owing to the difficulty which he found in conceiving how one kind of energy was transformed into another, he made the assumption that all kinds of energy were kinetic in nature, the physical effects produced by it depended upon the nature of the system in which the energy found its home. He made use of, Langrange's and Hamilton's equations, which gave very general methods for dealing with systems possessing only kinetic energies, to problems in physics and chemistry. His dissertation was subsequently expanded into a book called

Applications of Dynamics to Physics and Chemistry. He was awarded the Adams Prize in 1882, the dissertation for which was subsequently published as *A Treatise on Vortex Motion*. The results and ideas obtained during the course of this investigation came useful to him later when dealing with the structure of atoms, and the nature of the electric field.

Another problem he took up at this period was the investigation of the behaviour of moving charged particles in light of Maxwell's theory, to determine the magnetic force due to the charged moving particle, and also the mechanical force acting on the latter in a magnetic field. The results were published in the *Philosophical Magazine* in 1881. One of the important conclusions drawn was, that a sphere of radius a with charge e appeared to have an extra mass $\frac{2}{3} \frac{e^2}{a}$, corresponding to the fact that when it was set in motion energy had to be put in the electromagnetic field surrounding it. It was Sutherland who pointed out that if the radius a was taken sufficiently small, viz., about 2×10^{-13} cm., there was no need to suppose that the electron had any ordinary mass at all. This fundamental research of J. J. Thomson was the starting point of a number of important investigations by Abraham, Heaviside and Searle on the variation of the effective mass of an electron with velocity, with parallel experimental investigations by Kaufmann, Bucherer and Naumann, culminating in the Lorentz-Einstein transformations of the restricted theory of relativity and the principle of the equivalence of mass and energy. Another consequence of these investigations was the formulation of the electromagnetic theory of matter, viz., the masses of all kinds of matter and the forces between them are of electromagnetic origin. Later investigations have shown the untenability of this theory.

The experiments undertaken during this period by J. J. Thomson were chiefly on the suggestion of Lord Rayleigh who had succeeded Maxwell in 1879. They were on problems arising as consequences of Maxwell's theory, the most important of which was the determination of the ratio of the electrostatic to the electromagnetic systems of units, which according to the theory ought to be equal to the velocity of light.

In 1882 Thomson applied for the chair of applied mathematics at Owens College, but he was passed over in favour of Schuster. He was elected a Fellow

of the Royal Society in 1884, and in the same year he was chosen to succeed Lord Rayleigh as Cavendish professor of experimental physics, much to his and to everybody else's surprise as he states in his *Recollections*.

His tenure of the Cavendish Chair lasted from 1884-1918, when he was made Master of Trinity College. This period can be divided into two parts, the first from 1884-1895 was spent in organising the lecture and laboratory work for an increasing number of students, for which he had the able assistance of men like Glazebrook, Shaw, Fitzpatrick, Wetham, Searle. The beginning of the second period coincides with the new interest created in physics by the discoveries by Röntgen of X-rays, of a similar penetrating radiation from uranium compounds by Becquerel and the isolation of radium by the Curies. The time was ripe for a mass attack on such problems by a group of research students working under the guidance of a master investigator. This facility was provided by the Cambridge University introducing regulations by which graduates of other universities were admitted to Cambridge as research students, and were eligible to the award of the Master's degree after two years, on the submission of a thesis which was considered to be of distinction as a record of original research. The reputation which the Cavendish Laboratory had acquired as a home of research attracted a large number of able students from all over the world, and the first batch had included men like Rutherford, Townsend and McClelland.

The investigations carried on by J. J. Thomson during the years 1884-95 dealt with the phenomena of the discharge of electricity through gases. The theory of electrolytic dissociation, proposed in 1887 by Arrhenius and Vant Hoff, had attracted the attention of J. J. Thomson and he wanted to find out whether a similar splitting up of the gas molecule took place under the influence of the electric field present in the discharge tubes resulting in oppositely charged atomic ions. In 1897 he was able to convince himself that the gaseous dissociation was of quite a different type. As he states in his *Recollections* he was very clumsy with his fingers, and throughout his series of important investigations on gaseous discharge he had the technical assistance of others; the first of his collaborators being his old friend R. Threlfall, who subsequently became professor of physics in the University of Sydney. In later period he had an assistant named Everett, a very skilful

glass blower, from whom all the research students took lessons in the art. In recognition of the services rendered by him, Everett was awarded the honorary M.A. degree of Cambridge University, a few years before he died. Other important investigations undertaken in this period were the classical investigations of Callendar on the temperature variation of metallic resistance, and the investigations by C. T. R. Wilson on the formation of clouds, which found very important applications later.

Since the introduction of the new regulations in 1895 the number of research students increased rapidly, and there were at one time or another students from almost every important university in Europe, Asia, Africa and America. Amongst them may be mentioned the names of the present Lord Rayleigh, H. A. Wilson, Barkla, O. W. Richardson, J. C. McLennan, F. W. Aston, E. V. Appleton, G. P. Thomson, P. Langevin, Max Born, Pringsheim, Bumpstead, K. Przibram, Smoluchowski and Vegard. With the increase in the number of advanced students, a Cavendish Physical Society was started in 1893, the primary object of which was to discuss recently published papers in physics. Opportunity was also given to research students to give accounts of their own investigations. Such meetings were preceded by tea presided over usually by Lady Thomson. Besides this there was the daily institution of afternoon tea in the Professor's room, where the research workers daily met. All topics except physics were discussed at such gatherings, from American politics to golf and football, in all of which J. J. Thomson took a lively interest. In 1898 was instituted the annual dinner of the Cavendish Physical Society, which was attended by many past students. A notable feature of these gatherings was the songs composed for these occasions by research students, the most prominent of whom was A. A. Robb. They were sung to the tune of popular music hall songs. Even the intricate Maxwell's equations did not escape the attention of the versifiers. The writer remembers attending the annual dinner in 1909, the year Rutherford was awarded the Nobel Prize. The latter attended the dinner prior to his journey to Stockholm. Robb composed a special song for the occasion enumerating all the benefits which α -particles has conferred on Rutherford.

J. J. Thomson was a shy man, the essential kindness of whose nature was hidden under a gruff exterior and a booming voice. He possessed a dry

sense of humour which used to come out in his speeches and conversation. His experimental lectures were interspersed with many 'hoary annuals'. It is probably recounted of him that before beginning one of his stories he used to remark that 'those who attended my lectures last year need not laugh this time'. The affectionate regard of the research students towards 'J. J.' found expression in many stories about him, some of which were true and the others belonged to the category of 'ought to have been true'. His little eccentricities, and his occasional attempts to improve upon the experimental arrangement set up by his assistant Everett, some of which led to disaster were the subject of many amused comments. The existence of the positive electron was an article of belief with him, just as that of the neutron with Rutherford. While experimenting with positive rays one day J. J. Thomson obtained a photographic record which he thought was due to a positive particle of electron mass; further investigation showed that it to be due to a spurious effect.

The experimental researches carried out by him during the period 1895-1914 were concerned with the nature of the cathode ray, the phenomena of gaseous ionisation and conduction, and the properties of the positive rays. For two terms in the year he used to give a course of advanced lectures on these topics, which later appeared in book form under the title *Conduction of Electricity through Gases*, and became at once a classic in the subject.

He was the first to show that cathode rays could be deflected by electric as well as by magnetic fields, and his researches contributed mainly to the establishment of the view that they consisted of negatively charged particles, which were named corpuscles by Thomson, but later on the suggestion of Stoney the name electron was adopted. These electrons were shown by him to be an universal constituent of matter, and whether emitted by radioactive or incandescent bodies, or by photo electric emission, they gave the same value for e/m . Some of the earliest determinations of the latter were due to him. The first determinations of the electron charge were undertaken in his laboratory by Thomson, by Townsend and by H. A. Wilson. It was left to Millikan to improve on Wilson's method, which led to the famous oil drop method of determining 'e'.

His theoretical investigations during this period dealt with the structure of the atom, for which he proposed the model of a spherical volume distribution

of positive charge in whose atmosphere Z electrons were to be found, such that the total positive and negative charges were equal in amount. In such a model the electrons were subject to a quasi-elastic force. For this model he gave a formula for the multiple scattering of electrons and also of X-rays by thin layers of matter. The formula deduced for the last named effect, showed that the scattering per atom was proportional to Z , the number of electrons in it, and Barkla found that for some light gases with the exception of hydrogen, Z was about half the atomic weight—the first evidence of the fundamental role of nuclear charge in the theory of atomic and nuclear structure. He speculated deeply on the stability of electronic configurations in his atomic model and he showed how his model could explain the periodic law. But the key to the mystery of the atomic structure could only be found by the application of quantum theory by Bohr. Study of ionisation by X-rays and of the energy of electrons in photoelectric emission convinced J. J. Thomson as early as 1903, that the energy of electro-magnetic radiation was not continuously spread over the whole wave front but was concentrated in specks on the wave surface, *i.e.*, the energy was propagated in separate bundles. He could never accept wholeheartedly the implications of the Quantum Theory; probably the difficulty of forming a model of the 'quantum of action' prevented him from considering the theory seriously. He belonged to the school of Maxwell, Kelvin and Rayleigh, who had definite views on the importance of using models as an aid to physical discoveries. His own attitude is shown in his most successful text book *Elements of Electricity and Magnetism* in which all the properties of the electro-magnetic field are expressed in terms of Faraday's tubes of force.

Towards the end of the period under review Thomson took to the study of positive rays; he devised the parabolic method of focussing charged particles with the same e/m . The most important result obtained by him was the separation of the two isotopes of neon—the possibility of the existence of such isotopes had just been suggested by Soddy, from a study of the transformation of radioactive elements. Later Aston working in Thomson's laboratory considerably improved the focussing of the apparatus and made it into a precision method of determining atomic masses.

The work in the Cavendish Laboratory suffered from the outbreak of the last War, most of the

workers were diverted to war work. Thomson was made a member of the Central Committee of the Board of Invention and Research. During this period he was also elected President of the Royal Society. In 1918 he was appointed Master of Trinity College, Cambridge, upon which he resigned his Cavendish professorship. Rutherford was elected to succeed him; but he continued to work in the Cavendish Laboratory with his assistant and a couple of research students.

With the retirement of Thomson, a great change in the technique of the research work carried out in the Cavendish Laboratory took place. During his regime the equipment of most of the research scholars consisted of a Töpler pump, with charcoal and liquid air for producing high vacuum. Each student had to build up his own apparatus which was made chiefly of glass, and the ionisation currents were measured chiefly with the help of Wilson's tilted electroscope. Rutherford also did all his fundamental investigations with the aid of simple apparatus like the alpha-ray electroscope and the scintillation microscope, but he recognized the change that was coming in the technique of physical investigations. He gave facilities to Kapitza to build up an arrangement for producing intense magnetic fields, and started the Mond Laboratory for low temperature work. Cockcroft and Walton were given facility for setting up high voltage generators for nuclear disintegration work, and one of Rutherford's last acts was to obtain a donation of £250,000/- from Sir Herbert Austin for erecting a cyclotron.

Compared to the present scale of expenditure in the Cavendish Laboratory, it is interesting to note that in 1912-13 the extra amount spent on research by 40 students came up to about £550/-. In his *Recollections* Thomson makes the following confession 'It is not the first discovery of some new physical phenomena that is costly, *e.g.*, the discovery of X-rays by Röntgen, or radium by the Curies, or the long continued experiments of C. T. R. Wilson (leading to the visualisation of tracks of ionising particles) cost quite insignificant sums. Discoveries such as those were due to what cannot be bought, to keen power of observation, to physical insight, to an enthusiasm that does not falter until the difficulties and discrepancies which attend pioneering work is overcome'. He continues 'that when the first discovery is made, the effect observed is generally small and require a succession of lengthy

experiments to obtain trustworthy results. It is the attempt to get larger results that is so expensive . . . such money is however well spent for it enables us to obtain them more quickly and with greater certainty". As will be evident from the account given above, his own investigations were of the pioneer type. He was interested more in the discovery of new phenomena rather than in the complete and accurate survey of a limited region.

After his retirement he paid his last visit to America in 1923, when he delivered a course of lectures on *Electrons in Chemistry*, which showed

his interest in the nature of the chemical bond. In 1936 he published his *Recollections and Reflections*. Those who are familiar with pre-war Cambridge will find his reminiscences of men and events very delightful and entertaining. Of wider interest is his recollections and estimates of his teachers and great contemporaries.

He married the daughter of Sir George Paget, a well-known Cambridge physician. He is survived by a daughter and a son Prof. G. P. Thomson.

D. M. Bose.

ENERGY IN PETROL TANK

When we drive up to a gasoline filling station in our car and say calmly "ten gallons please", we are getting comfortably contained within a volume of about one and one-third cubic feet in our tank, the power equivalent, if expressed in terms of water in a reservoir elevated 100 feet, of 1,800 tons of water occupying nearly 600,000 cubic feet of volume.

—Sigma Xi Quarterly.

The Late Sir Oliver Lodge

WITH the death of Sir Oliver Lodge is removed from our midst one of those few physicists who, though brought up in the mechanistic school of rigid determinism, lived to see the advent of new physics in which determinism had hardly any place. Lodge belonged to the school of Kelvin, Poynting, Hertz, Crookes and Rayleigh to whom Newtonian mechanics and classical electrodynamics founded by Faraday, Maxwell, Lorentz represented all in physics. The few of that generation who lived down to the present time could hardly adapt themselves to the strange ideas of modern physics in which laws of mechanics are flagrantly violated, the distinction between matter and energy is fast disappearing and determinism giving place to uncertainty. Sir Oliver was no exception to this. It therefore seems strange that in spite of an essentially mechanistic outlook of the universe, Sir Oliver could, at the same time, be a staunch believer in psychical research and apply with characteristic energy and zeal his critical faculties for studying mysteries like the survival of human personality after death.

Oliver Joseph Lodge was born at Penkull in Staffordshire on 12th June, 1851. He was the eldest son of Oliver Lodge, who owned a prosperous business of supplying blue-clay to potters. He began his education in Grammar School at Newport. At the early age of 14, Lodge left the school and was admitted into his father's business. At this time the boy chanced to come across a few old copies of *English Mechanics* which he read with great interest. The natural inclination of the boy towards science, which lay dormant, was thereby kindled. He grew restless, but, it was not until seven years had elapsed that he managed with great difficulty to obtain permission from his father to leave the business and step into the path of science.

At the age of 21, Lodge joined the University College at London where he took his D.Sc. degree in 1881 and was appointed assistant professor of physics. Sixteen years later he was elected professor of physics in the University of Liverpool, and was at the same time made a fellow of the Royal Society. In 1900, he was appointed the first principal of

Birmingham University through the influence of Joseph Chamberlain. He obtained knighthood in 1902. During the last great war he served as a member of the Central Committee, which was the Governing Body of the Board of Invention and Research instituted in July 1915 with a view to giving expert advice to the Admiralty for organizing scientific efforts to meet the requirements of the Naval Service. Lodge resigned the principalship of the Birmingham University in 1919 and went to live in retirement near Salisbury where he breathed his last on August 22, 1940.

While at the University College, London, Lodge was attracted by the theoretical work of Clerk Maxwell which predicted the existence of electromagnetic waves. He naturally commenced his first experiments on electrical phenomena and related subjects. The nature of the discharge of Leyden jars was studied by him in great detail and in this connection he carried out illustrative experiments on the performance of lightning conductors. He was the first to call attention to the fact that the self-inductance of lightning conductors is of much more importance than the direct current conductivity. Even if the conductivity is adequate, lightning conductors may prove to be dangerous instead of being of any protective value, if the self-inductance is not low. In 1889, he delivered a lecture before the Royal Institution on the oscillatory discharge of a Leyden jar where he performed experiments to demonstrate the effects of the discharge on wires as well as in free space. He was no doubt working with electro-magnetic waves the existence of which had been established a year ago by himself and more satisfactorily by Heinrich Hertz. Like Sir J. C. Bose he repeated all the experiments of Hertz on electric waves using as detector a Branly's coherer modified by himself to increase its efficiency. He demonstrated beautifully the reception of the waves at a distance of a few hundred yards from the emitter—the waves being made perceptible by the deflection of a spot of light or by the impression of the signals on tape with the help of a siphon recorder. By this time he had also devised a new type of coherer which consisted of a greasy steel wheel maintained in constant rotation with its edge

dipping in a pool of mercury. Normally the pool is divided into two distinct portions having no conducting connection between them. When electric waves are incident the two portions coalesce and a conducting link is established.

Though Lodge performed his experiments on electric waves with great success, the idea that these waves could be made use of for wireless communication escaped his notice. In this respect he shared the lot of a number of physicists like Hertz, Dolbear, Righi and Hughes who had within their grasp the secret of an achievement of outstanding importance but, strangely enough, failed to realize it. This failure of so many brilliant workers to apply the results of a first class scientific discovery was due to a cause which is unfortunately only too common in the scientific world. A scientist, cloistered as he is in his research laboratory investigating the laws of nature and engrossed in the work of imparting knowledge to his pupils, finds little time and also frequently has little inclination to exploit the discoveries by applying them to satisfy some daily need of mankind. In this connection Lodge's own words may be quoted: "I was too busy with teaching work to take up telegraphic or any other development. Nor had I the foresight to perceive, what was turned out to be, its extraordinary importance to the Navy, the merchant service, and, indeed, land and war service, too." Speaking on the work of Lodge, Professor J. H. Poynting has said, "Whatever developments and changes may be made in the system of wireless telegraphy, there can be no doubt that Sir Oliver Lodge will always be recognised as one of the founders of the system, as a pioneer in researches on which others have built." Even after Marconi had succeeded in inventing his own system of wireless telegraphy, Lodge introduced certain improvements without which the practical applications of any system of wireless would have been seriously limited. In 1897, Lodge called attention to the fact that by tuning the transmitter and the receiver,—which he described as *syntonic telegraphy*—privacy of the messages transmitted and freedom from interference could be ensured. This invention was no doubt an invaluable and essential step towards the progress of wireless communication.

Lodge carried out successfully a very important experiment on the relative motion of matter and ether before the advent of the theory of relativity, at a time when the perplexing question of the reality or otherwise of the ether of space was agitating the

mind of the scientific world. With great ingenuity Lodge devised his famous ether-drift experiment which showed that the velocity of light just outside moving matter is not influenced by the motion of the matter.

Although an experimental physicist, Lodge was a man of no small literary ability. He is the author of a large number of books on varied topics. His style is simple and vivid and unrivalled for clear exposition. This is particularly evident in his admirable work, *Pioneers of Science*, which, though written half a century ago, is still read with profit and pleasure by many. We cannot help quoting here from this book his striking description of the true man of science. He says—"They are men "who seem of another age and country, who look upon the bustle and feverish activity and are not infected by it, who watch others achieving prizes of riches and pleasure and are not disturbed, who look on the world and the universe they are born in with quite other eyes." They are distinct from men "using the name of science but working for their own ends, jostling and scrambling just as they would jostle and scramble in any other trade or profession. These may be workers, they may and do advance knowledge, but they are never pioneers."

While engaged in purely scientific pursuits, Sir Oliver also devoted his time to psychical researches. In the early eighties there was a great vogue of experimenting with the so-called *spiritualistic medium*, not only amongst the laymen but also amongst distinguished scientists to whom the laymen looked for opinion and guidance. There were individuals, men and women, who claimed that while falling into a trance they could be in communion with spirits of the other world. Seances used to be held in celebrated centres of learning in which famous scientific men participated to find out the truth of such claims. We find Sir Oliver also drawn into the whirl of occult research at this time. But, while in course of the last sixty years there has been a general tendency amongst scientists to dissociate themselves from these investigations or, at any rate, not to commit themselves to any definite view regarding the nature of these phenomena, Lodge continued in his investigations and remained all along his life a staunch spiritualist. We find however, at times, his critical scientific mind asking pertinent questions and trying to interpret his experiences and observations in terms of the laws of the physical world. Thus, when a *medium* is found

to be detected in fraud he says that it does not necessarily follow that the medium has no psychic power. He would rather believe that when the control is lax and the medium finds that it is easier to produce the expected effects by fraud than by his psychical power he is tempted to take recourse to dubious methods. Again, when he tested the powers of the well-known medium Usapia Palladino, an Italian peasant woman, at the place of Professor Richet, he was satisfied about the genuineness of the phenomenon produced, namely, bulging out of curtains without any apparent connection with Usapia. He explained the phenomenon by saying that the medium had the power of thrusting out a sort of extra arm having mechanical qualities. To Lodge the spirit-world was a matter of intense faith.

This undoubtedly led him to publish the famous work, *My Son Raymond—Life and Death*, embodying his experiences of the spiritual sittings in which he believed that the spirit of Raymond, a young son of his who had lost his life in the last great war, appeared and made his presence felt. We are not in a position here to give any opinion on this aspect of the activities of Sir Oliver. Be it said, however, that his writings on this subject, coming as they were from a man of his scientific eminence, found eager readers amongst the most intellectual persons and, what is more, had been a source of solace and comfort to thousands who had lost their near and dear ones.

S. K. Mitra.

HEALTHIER PLANTS

From the Horticultural Department of the American Chemical Paint Company comes news of the commercial production of a vitamin-hormone stimulant, Transplantone, for plants, that not only invigorates old roots but also multiplies the production of new ones, reduces the loss which frequently occurs with transplanting operations, and reduces wilting. It is applied to rooted plants to add to existing root growth and to force their general growth.

Transplantone is a water-soluble powder impregnated with vitamin B₁ and other parts of vitamin B₁ fraction, plus root-promoting hormones. The hormone initiates root growth and plant physiologists assert that the Vitamin B chemicals are necessary for the maintenance of their growth. That it is quite concentrated is obvious for it requires only one level teaspoonful to a gallon of water to make a stock solution which is then further diluted. Seedlings may be lightly sprinkled weekly, or it may be applied to plants set out in the soil, whether they be trees, shrubs, vines, annuals, or perennials. In the case of plants which are set out without a ball of earth, the manufacturer recommends that the roots be soaked in the stock solution for an hour. Treatment usually results in vigorous and extensive root growth and this, in turn, requires more frequent watering than is ordinarily necessary.

The manufacturer further claims that, owing to frequent clipping, grass is unable to produce enough vitamin and hormone naturally for the roots and that watering with an ounce of stock solution to three quarts of water will improve turf quality. Sods similarly treated before being set in place will also readily form new roots.

Notes and News

Ageing of Populations and its Consequence

IN his presidential address at the centenary celebrations of the American Statistical Association Prof. Raymond Pearl pointed out how in many civilized countries there is a marked tendency for populations to age with time and how this has an important bearing upon the aggregate behaviour of those populations and upon the probable course and outcome of enterprises upon which the people embark as a whole.

Biologically the life cycle of man falls into three stages—pre-reproductive, reproductive and post-reproductive. People in the reproductive phase have to do the work not only to get their own livings but also the livings of the young and the major part of the livings of the old persons in the post-reproductive phase. From these considerations arises a three-fold age classification of 0-14 years, 15-49 years, and 50 and above. About 50 p.c. of all populations generally fall into 15-49 class but in the other two classes it varies largely. The population of India in 1931 had 39.9 p.c. in the pre-reproductive phase, 50.4 p.c. in the reproductive phase and only 9.7 p.c. in the post-reproductive phase, whereas in the same year the population of France had only 22.9 p.c. in the pre-reproductive phase, 51.4 p.c. in the reproductive phase, and 25.7 p.c. in the post-reproductive phase. This shows how the two populations are deeply differentiated biologically.

War is one of the significant forms of aggregate behaviour of a population, and a study of the populations of the chief protagonists in World War I of 1914 and World War II of 1939 yields useful information. On the figures of 1910-11, Germany and Austria had resources of upwards of 64 million persons of whom 33.5 p.c. were in the pre-reproductive phase, 50.8 p.c. in the reproductive phase, upon whom naturally fell the burden of fighting and producing goods for the troops and civil population, and 15.7 p.c. were over 50 years of age. Among the allies (France, England, and Belgium) the corresponding figures were a total population of 87.5

millions, of whom 52.2 p.c. fell in the fighter-worker class, in the under-15 phase were 28.5 p.c. and over 50 years about 19.3 p.c. At the outbreak of World War II the allies had total population resources of 87 millions of whom more than 25 p.c. (as against 19 p.c. in 1914) were of post-reproductive age. The fighter-workers show a decrease from 52.2 to 51.3 p.c. and instead of 28.5 p.c. of youngsters coming of age there are only 23.6 p.c. The population resources controlled by Germany has a total of 90 millions of which 53.7 p.c. (an increase over the 1914 figure) are in the fighter-worker phase while there are 22.4 p.c. in the older group and 23.8 p.c. in the group of youngsters. So far as population aspects of war are concerned the advantages and disadvantages accruing from that source have become reversed in the quarter of a century. Falling birth rates on one side and rising birth rates on the other have been in the main responsible. Analysing the white population statistics in the United States in 1840 and 1930 Prof. Pearl shows that while in 1840 each 1,000 worker had 1,984 persons, younger and older, to take care of, in 1930 each 1,000 supported only 880. The ever-increasing use of such devices as contraception as adaptive procedures to ease the burden of ageing populations may make life easier for the present generation but there is the fear that in future there will be none to live.

Improvements in the Electron Microscope

DRS L. MARTON and V. K. Zworykin of the RCA Manufacturing Co., Camden, N. J., U. S. A. have developed a new electron microscope giving a total useful magnification of 100,000 diameters. The instrument employs three magnetic lenses, the optical equivalents of a condenser, objective and projector. The first stage or intermediate image is produced by the objective at a magnification of 100 diameters. This image is subjected to a further magnification of 250 by the projector lens which throws the final image at a magnification of 25,000 on to a fluorescent screen for direct observation or on a photographic plate. The photographic record

produces a further enlargement of 4 diameters giving a total useful magnification of 100,000 diameters. The technique of preparing specimens for examination has also been carried to a stage where the instrument is ready for use in a research laboratory. Such objects as diatoms, viruses and bacteria which were far beyond the resolving power of optical microscopes have been brought under direct visual observation. The use of the instrument promises to yield much new knowledge about particles of colloidal dimensions.

Index of Body Build

Since Kretschmer emphatically and persistently directed attention to the correlations between habit of body and psychological and temperamental characteristics, the need for seeking a formula for an index of body build has been strongly felt by workers in the field. Various proposals have been made from time to time but none were found suitable as the human body from the geometrical point of view is a solid of extremely complex shape and is difficult to express adequately by a simple numerical statement or formula. The difficulty lies in the fact that changes in the size of the body occur in all three of the fundamental reference planes of the body, viz., length, breadth, and thickness. After surveying the proposals Prof. R. Pearl suggests that the formula, *Habitus*

$$\text{Index} = \frac{100 (\text{chest girth} + \text{abdominal girth})}{\text{Stature}}, \text{ would meet}$$

fairly most of the requirements. Evidently the value of the index would increase as we pass from tall and skinny persons to short and stout persons, who will have the highest indexes. Another advantage is that the index involves only linear measurements. Moreover, all the three dimensions are definitely located and biologically significant. By actual trial this index has proved to reflect in a sensitive manner the differences between individuals in body build, and those in the same individual consequent upon changes in his body build with advancing age.

Automatic Distress Signals

THE International Marine Radio Co., Ltd., has devised a new type of safety flashing light 'Raft-o-lite', which has been approved by the British Ministry of Shipping. The arrangement comprises a battery and light in a watertight case, provided with a float. When floating it will always assume a vertical position and the light is automatically switched on. When placed in an inverted or horizontal position the light is not in use. A flasher

is incorporated and this is designed to emit automatically the international distress signal, 'S.O.S.' The flashing light after being automatically switched on will continue for at least forty-eight hours. These lights will be particularly suitable for oil-burning ships or oil tankers, where oil floating on the surface of water makes it dangerous to use open flames.

Coloured Photographs of the Inside of Human Body

SURGEONS often use instruments to examine visually the interior of different parts of the human body. Three American surgeons have now devised an arrangement to take photographs in natural colours of the interior of the human body by adapting a miniature colour camera to the exploring instruments used by surgeons. They have actually taken photographs of the interior of the bladder by adapting the camera to a cystoscope. With the help of exploring instruments like the cystoscope it is possible to see inside the body cavities through a series of lenses arranged in a flexible tube with a tiny electrical bulb at its end. It is also possible to perform delicate operations with instruments which are thrust through the tube and manipulated with the help of the light. But with these only the operating surgeons could watch the operation. The new photographic method will make it possible to photograph the various stages of the operation and demonstrate it to others. Another great advantage is that the various kinds of cancerous and other growths, injuries and stones etc., can be photographed in their natural colours and these may be of aid to physicians in identifying and treating them.

New High Speed X-ray

DR CHARLES M. SLACK, research physicist of the Westinghouse Lamp Division, New Jersey, has developed a new ultra-high speed X-ray tube that would make it possible to take photographs of the inner structure of rapidly moving opaque objects or of objects reacting to a sudden external force or blow. High speed photography enables taking photos of bullets in air but the new device will make it possible to see what is happening to the bullet in its course through wood or other hard opaque substances. Engineers hope that the new device will enable machine and motor builders to study internal strains in rapidly moving parts. Even rifle makers will be able to determine any slight deflection of the bullet in its passage through the gun barrel. High speed X-ray tubes in use at

present permit exposure times of nearly $1/100$ of a second which is fast enough for taking pictures of objects at rest. But an exposure of even $1/1000$ of a second would be far too long for high speed work. The new tube is designed to receive a heavy surge of current only momentarily, from a series of condensers. The current flows for only about $1/1,000,000$ of a second, creating X-rays, and the film also is exposed only during this extremely short interval.

Power From Uranium

ABOUT 35 years ago Einstein established the fact that mass and energy are quantitatively related. If a suitable method could be found to annihilate one pound of matter it would be possible to obtain from it 10^{10} kilowatt-hours of energy. The possibility was there and since then the search for a suitable process for this annihilation of matter or atom-smashing business or scientifically speaking transmutation of elements has been attempted by scientists all over the world. But the economic utilisation of the energy released was out of question.

This situation has recently changed due to the discovery of the peculiar behaviour of the nature's heaviest metal uranium (in the isotope 235) under neutron bombardment. When uranium is hit by a neutron that enters its nucleus, the atomic weight becomes 236 and it turns into a non-stable exploding atom which splits into two lighter atoms and the binding energy of the uranium atom to the extent of 200,000,000 electron volts is liberated. Recent experiments have definitely established that only one low-energy neutron, slowed down by water, would behave like a trigger setting off the energy liberation from uranium-235. This neutron also need not be supplied by any apparatus, but any neutron liberated from air by constant bombardment of Cosmic rays, and slowed down by passage through ordinary water will serve the purpose. All that is necessary to start Uranium-235 liberate its energy is to place it in an environment of ordinary water. A neutron liberated by Cosmic rays will be slowed down by water before it can hit the uranium atom. The atom will be split into two parts, liberating 200,000,000 volts of atomic binding energy and in the process other neutrons will be liberated from the U-235 atom. These neutrons slowed down by the water will split other U-235 atoms. The process continues as long as there are atoms left and there are 2500 billion atoms per gram.

The energy liberated from the atoms heats up the water so that it turns into steam which can then

be put to work. Very small energy is required to bombard uranium-235. But the problem of obtaining uranium-235 in commercial quantities and at an economic cost must be solved first. Commercial uranium is a mixture of three isotopes of uranium—0.006% of the atomic weight 234, 0.7% of 235, and over 99% of 238. Attempts are however already being made to separate U-235 on a large scale. Prof. Wilhelm Krasny-Ergen of Stockholm have set up 30 ft. thermal diffusion tubes which have made possible an yield of 1.3 mgm. of U-235 per day. This would require about 3 years to get one gram of the substance.

An idea of the tremendous amount of heat released by uranium-235 can be had from the following facts: one pound of uranium-235 will give up 37 billion (37,000,000,000) B.t.u. on disintegration. This heat is equivalent to 1650 tons of Bengal coal (calorific value—10,000 B.t.u. per lb.). Assuming the present heat efficiency of 25% in modern steam power plants, this amount of heat will generate 2,700,000 kilowatt-hour by the existing methods. This would be enough to operate a 100 horse power motor continuously at full load for three years.

The best uranium ore is "pitch blende" in which it is in the form of its oxide U_3O_8 , which is being used for many years as the commercial source of radium. At present there are pitch blende mines in Western Canada, in Australia, in Belgian Congo, and in Germany. There is some pitch blende deposits in India in the province of Behar. The present price of uranium oxide is about Rs. 20/- per pound, and that of commercial uranium metal about Rs. 160/- per pound.

It is very likely that the present central power plants will not be so much affected but considering its extreme concentration of energy, uranium-235 has an immense possibility as the future fuel for the powering of the aeroplanes, automobiles, ships, etc. With no improvements in the present conversion efficiency a car that runs 15 miles on one gallon of petrol would run about four million miles on one pound of uranium-235. But the technique is yet to be developed.

N. K. S. G.

Announcement

MR M. SWAMINATHAN, M.Sc., chemist, Nutrition Research Laboratories, Indian Research Fund Association, Coonor, has been awarded the D.Sc., degree in chemistry of Madras University, for his thesis "Nicotinic Acid and its rôle in Nutrition".

SCIENCE IN INDUSTRY

Mixtures of Staple Fibres with Indian Cottons

WITH the comparatively recent development of staple fibre—cut filaments of specified length, diameter and denier—leading to its being spun pure or blended with cotton, wool, etc., on the existing machinery, the textile industry has been offered an excellent material for producing an almost unlimited variety of yarns with novel characteristics. It has, for instance, been used in the manufacture of fancy plyed or crepe yarn, in hosiery goods, in union fabrics in which contrast effects have been produced, in imitation of light worsteds etc. The demand for these fibres has been increasing so fast that within the last decade their world consumption has risen from a bare 9 million to 1,000 million pounds. The Indian mills are evincing considerable interest in this new material and in the wide possibilities it may open up for producing novel and attractive fabrics when mixed with cotton. At the Technological Laboratory of the Indian Central Cotton Committee experiments have been undertaken to study the spinning quality of mixtures of Indian cottons with suitable staple fibres. Some preliminary work done at the Laboratory gave interesting results which were published in a bulletin. Recently more detailed study have been made, especially of the optimum conditions for spinning mixtures of staple fibre, 100" and 1.5 denier, with three Indian cottons, Jayawant, Cambodia Co.2 and Surat 1027 A.L.F., in which the proportions of staple fibre were 10, 15, 20 and 30 per cents. The pure staple fibre, the cottons and their mixtures were spun with different twist multipliers and drafts in order to investigate the effect of these important factors on the spinning behaviour of the material and the quality of the yarns.

It has been found that higher twists and larger proportions of staple fibre tend to reduce the dry yarn strength, while with lower twists the addition of staple fibre up to 20% improve the yarn strength. The wet strength decreases progressively with increase in the proportion of staple fibre in the mixtures, while the elasticity of the yarn increases. For the lower proportions of staple fibre the dry

strength is very nearly equal to the wet strength, while the wet count work product is always higher than the dry count work product. Full details of this work will be published in a bulletin.

Jute Research and Universities

REALISING the importance of carrying out research on jute in the closest touch with other branches of scientific research, the Indian Central Jute Committee have decided on the policy of collaboration with the Universities of Calcutta and Dacca and to co-opt some professors of these universities on its Technological and Agricultural Research Sub-Committee. It is interesting to note here that in course of our review of the Report of the Imperial Council of Agricultural Research in the July, 1940 issue of this journal entitled "Agricultural Research in India" we commented on the lack of co-operation between the Jute Committee and the Universities at Dacca and Calcutta. We are glad now that steps are being taken to utilise the university laboratories for industrial researches. The immediate objects of collaboration are primarily two-fold. First, the Committee thought that the university scientists, many of whom were perhaps working on similar lines, might offer valuable advice on the work that was being done in the Committee's Research Sections. Even if their immediate work might be different from the investigations undertaken by the different technical sections of the Committee they felt that their familiarity with the basic scientific methods and processes might be of considerable help and value to the Committee's research workers. Secondly, the Committee were inclined to think that the universities, on their part, could also further their aims and objects by undertaking fundamental research on a number of subjects for which there was not, and indeed could not be, any room in the programmes of work laid down for the different sections of the Committee. Such fundamental investigations might lead to results of far-reaching consequence which might be of abiding benefit to the jute industry of this country.

Indian Material for a Harmless Dye

KAMALA, an orange-red powder consisting of minute red glands and hair of the fruit of an ever-green tree *Mallotus*, may have a synthetic dye industry of her own, following investigations at the Forest Research Institute, Dehra Dun. As a dye, it is used for imparting to silk and wool a bright orange or flame colour. The tree is common in the United Provinces and occurs in profusion in Bengal, Bombay and Orissa. The ripe capsules are gathered in February or March and the powder is collected either dry, by shaking the capsules in a bag, or wet, by stirring them in water and collecting the sediment in the form of cakes. Kamala has been used as a dye and an anthelmintic in India for centuries and has been exported to Europe and America for the same purpose for a long time. Lately owing to high adulteration there has been a setback in the export of this product.

The experiments at the Institute show that Kamala, when properly prepared, should not only find favour with the foreign importers once again, but it can also be profitably utilised in this country for a variety of purposes. The colouring matter, being soluble in oils and fats, could be employed for colouring hair oils, butter and its substitutes and in the form of its water-soluble sodium or ammonium salt, for colouring aerated waters.

In India foodstuffs are often deliberately coloured, but India is not yet producing synthetic dyes, all of which have to be imported, and therefore any suitable vegetable raw material for the extraction of an edible dye would find a ready market. In the United Provinces alone about 1,000 maunds of Kamala is collected annually, and the whole of it could be converted into dye and made available for colouring silk, wool, oils, fats, food materials, etc.

Marketing of Jute

THE first report of the Marketing Department of the Indian Central Jute Committee has just been issued. It confirms the general opinion that the present jute forecasts have proved of little practical value in providing for correct estimates of acreage and outturn.

The report is the result of intensive enquiry in 26 jute growing districts. Starting with a concise, but complete, description of the present system of crop forecasting, the report proceeds to examine at length the various stages through which the fibre passes from the grower to manufacturer or shipper as well as the details of the marketing organisation

and the methods of buying and selling that are followed at all these stages.

The enquiry has also established that, during the season, 1937-38, growers sold 75 per cent. of their jute in villages, 20 per cent. in *hats* and only 5 per cent. in baling centres. The early sales and the disposal of threefourths of the crop in villages are attributed mainly to the lack of growers' holding power, as well as to the prevalence of various market allowances and deductions, difficulties of rural transport, and dearth of storage facilities for growers in the markets. With a view to establish direct contact between producers and consumers, it is recommended that regulated markets, licensed warehouses, and co-operative Jute Sales Societies should be started (first as experimental measures) in villages, assembling centres and in Calcutta. The abolition by legislation of the existing market allowances has also been recommended. As the sale of jute in a completely unassorted condition, at all marketing stages up country, has led to the underestimation of quality by buyers, the universal adoption of sales by assortment and the introduction of grading in villages has been recommended. A price structure, which is an analysis of the various costs incurred on the movement of jute from villages to Calcutta, reveals the interesting fact that the growers, on an average, received a little less than 81 per cent. of the Calcutta landed price of jute in October, 1937. And out of the remaining 19 per cent., 10.1 per cent. was spent on handling and transportation, 3 per cent. was paid as market allowances and 6 per cent. was absorbed as standing charges of *kutchas* balers. It is also recommended that the classification and grade of jute should be fixed on scientific basis and experiments should be undertaken for the determination of the natural moisture in jute.

Industrial Researches at Forest Institute.

NEARLY five tons of a wide variety of papers—writing, printing, typing, wrapping, newsprint, drying, cover and brown papers—and mounting boards were made in the experimental factory of the Paper Pulp Section at the Forest Research Institute, Dehra Dun. Of these about three tons were supplied to various Government institutions, besides 1,100 lbs. of pulp supplied to the Archaeological Survey of India for use in the preservation of monuments. On paper made at the Institute was printed the latest annual report on forest research, about which a note was published in the last issue of this journal (p. 163).

Researches are being continued on the manufacture of wrapping paper from raw materials avail-

able in India's forests. Paper has been made both in the laboratory and at the factory from ulla sulphate pulp alone, and from mixtures of ulla sulphate pulp with *chir* sulphate and *chir* mechanical pulp. By grinding *chir* (*Pinus longifolia*) and *bendi* (*Kydia calycina*), attempts are being made to prepare mechanical pulp for the production of cheap wrapping papers and newsprint quality of papers. A fairly satisfactory quality of newsprint has been made from a mixture of *bendi* mechanical pulp and bamboo chemical pulp, and studies are being continued on the production of mechanical pulp from *bendi* and other soft woods.

With a grant made by the Government of the United Provinces, studies have been made of the possibilities of improving paper making processes, so that hand paper-making can be carried on as a cottage industry. Writing papers and envelopes (white and coloured), drawing papers, blotting papers, cover papers, wall papers, greeting cards, etc., have been made out of raw materials such as tailors' cuttings, paper cuttings, bamboo and grass pulp, etc. Other raw materials available in or near the villages will also be tried.

Another interesting investigation now being carried on is that for finding suitable Indian timbers

for the construction and repairs of aircraft. Cypress from Garhwal in the green condition, gave encouraging results, but the timber seems to become brashy during seasoning. In a timber structure the joint forms the weakest link, and an investigation was started to develop proper methods of making joints. It has now been found that the incorporation of a small piece of bamboo ring, costing practically nothing, in the joint more than doubles its load-carrying capacity. Further tests are proceeding.

Identifications of timbers form a routine work at the Institute and the total number of timbers identified during 1938-39 was about 400. Among those who benefited from the assistance given by the Institute were the different railways, the Defence Department, museums, the Meteorological Department, jute mills and various industries which use timbers in some form or other. On an enquiry from the Meteorologist, Upper Air Observatory, Agra, a sample of imported wood reported to be a good thermal insulator, has been identified as balsa (*Ochroma* sp.) of Central America. Sujit (*Cryptomeria japonica*) from Bengal and pangra (*Erythrina suberosa*) from the United Provinces were recommended for trial as Indian substitutes.

Leather Industry in Bengal

B. M. DAS

Superintendent, Bengal Tanning Institute, Calcutta.

LEATHER industry consists of making leather from hides and skins and manufacturing useful articles of leather. It has four main branches, viz., collection of hides and skins, tanning, shoe making, and manufacture of other leather goods besides shoes. Each of these is sufficiently big in scope to form an industry or trade by itself.

HIDE AND SKIN TRADE

Bengal produces chiefly cattle hides and goat skins. Buffalo hides and sheep skins are available to a lesser extent. Besides the hides and skins of these domestic animals, there is quite a large supply of skins of such reptiles as lizards, snakes, pythons and crocodiles. The estimated annual value of raw hides and skins produced in Bengal is about one

and a half crore of rupees approximately made up as follows:—

	Number of pieces.	Value in rupees.
Cattle hides ...	60.50 lakhs.	120 lakhs.
Buffalo hides ...	1.81 "	10 "
Goat skins ...	15.10 "	15 "
Sheep skins ...	2.20 "	1 "
Reptile skins ...	...	8 "
Total ..		154 lakhs of rupees.

Besides these indigenous hides and skins of Bengal, large quantities are sent to Calcutta from the Punjab, U. P., Bihar, C. P., and Assam.

Calcutta is the biggest market for raw hides and skins where purchases are made by tanners of Calcutta, Madras, Cawnpore and by hide and skin exporting firms which have their offices in Calcutta. So although Bengal's own production of hides and skins is worth a little over 1½ crores of rupees the total trade in hides and skins in Bengal is valued at about Rs. 4¼ crores annually. The total trade is tabulated below ; the figures are for 1937-38.

Export to foreign countries	...	Rs. 270 lakhs.
Madras	...	96.5 "
Cawnpore	...	1.5 "
Tanned in Calcutta	...	53.7 "

It will be seen from the above figures that of the total raw hides and skins disposed of in Calcutta 12 per cent only are locally tanned.

Good deal of work is involved in the hide and skin trade and a large number of people are engaged in it. The work consists of flaying, curing and preservation, collection from producing centres, despatching to principal markets, grading and selling to customers. In case of hides and skins exported to foreign countries further work has to be done, such as cleaning, trimming, grading according to exporter's standards of assortment, baling and shipping. Most of these works are technical in which considerable skill and experience are necessary to carry them out efficiently.

Flaying is the first operation. About 80 per cent of the cattle and buffalo hides of Bengal are derived from animals that die a natural death from old age or disease. The carcasses are usually flayed by village *chamars* and the hides are, in many instances, their perquisites in return of the labour involved in the disposal of the dead body and its flaying. The *chamars* are on the whole skilful flayers and the hides from dead animals are usually taken off without being damaged by cuts and scores. In cities like Calcutta and Dacca a number of cattle are killed in slaughter houses for meat. These hides are flayed by professional butchers. They pay more attention to the meat than to the hide and in doing so invariably damage the hides by cuts and deep knife marks. The Indian Marketing Board is trying to improve flaying at slaughter houses by paying bonuses to butchers for good work.

If hides and skins cannot be put to tanning process within 12 to 24 hours of flaying they must be preserved from rotting and decay until they can be tanned. In most cases it is not possible to tan hides and skins so soon after flaying as tanneries are far away from centres of collection of hides and skins and are often in

foreign countries and consequently several months usually elapse before they can be put to the tanning process. The process of preservation is technically called curing of which there are different methods. In the dry up-country centres of collection the hides and skins are simply dried out in the air. Cattle and buffalo hides of better quality are stretched lengthwise on wooden or bamboo frames and dried out in the stretched condition. These are called "Framed hides" in the trade. The inferior hides mostly derived from dead cattle are dried out simply by spreading them on the ground. On drying these hides shrink and crumple up and therefore they are known in the trade as "crumpled". On account of the long rainy season and the usual humid climate of Bengal curing by air drying is not possible in this province. In Bengal, hides and skins which have to be preserved long are cured by a special process called "Dry salting". This consists in spreading the hides and skins on the ground flesh side up and applying a solution of a saline earth, khari salt, 3 or 4 times with intermittent drying. When the hides and skins are suffused with this saline preservative, they are finally dried out. These are known in the trade as "dry-salted stocks". Goods of both the above two cures (air-dried and dry-salted) are meant for export overseas. The air-dried hides which are also called "flints" are arsenicated (dipped in a solution of white arsenic) before shipment to prevent ravages by moths and insects during transit. Goat and sheep skins for export are mostly dry-salted and to a very small extent air dried.

For local tanning green hides and skins, i.e., the hides and skins just after flaying are preferred. But if there be delay in sending them to tanneries they are preserved by the application of common salt on the flesh side but are kept in wet condition. These are known as "Wet salted" hides and skins. They keep sound only for a short time (from 6 to 8 weeks) and therefore this process of curing is followed only in the case of goods meant for tanning in India.

TANNING INDUSTRY

The main function of tanning is to convert the perishable raw hides and skins into a non-perishable substance which is called leather and to dress up this leather in a number of ways to make it suitable for the various uses to which leather is put.

Each variety of hide or skin is adapted to the manufacture of a particular variety or a number of varieties of leather depending on its basic

characteristics. For instance, a thick hard leather required for soles of shoes can only be made in this country from a buffalo hide which is naturally thick while a thin and soft leather for a wallet or money purse has to be made from a sheep skin which is thin and pliable by nature. Between these two extremes there are several varieties of leather which are commercially required and there are also raw hides and skins of suitable basic qualities for making them. In Bengal we have got the full range of raw hides and skins from the thick buffalo hide to the thin sheep skin which may be provided for nearly all varieties of leather in use.

TANNING MATERIALS

Commercial leathers in Bengal are manufactured mainly by two different processes of tanning, the vegetable and chrome. For the former, vegetable substances, e.g., barks, fruits, wood, leaves etc., containing an astringent material known as "Tannin" are employed. These are called the vegetable tanstuffs. In Bengal, barks of *babul* and *goran* and myrobalan nuts are principally used. Barks of *sonali*, *avaram* and wattle are also occasionally taken recourse to.

Babul bark (*Acacia arabica*) produces a good leather which satisfies not only popular taste but also the specification for leather required by the military department of Government of India. Buffalo hides for sole leather, and harness and saddlery leather for military and civilian use, cow hides for suit cases, straps etc., are tanned in large quantities with this bark in Northern India, in the up to date as well as in the small cottage tanneries. The total annual consumption of this bark in Calcutta alone is more than one lakh maunds. Out of this only twenty three thousand maunds are produced in Bengal while the balance is imported from the Punjab. This import could be stopped if the bark were collected in Bengal.

Goran bark (*Ceriops roxburghiana*) is exclusively a Bengal product. *Goran* belongs to the species of plants collectively known as mangroves and grows extensively in the swamps of the Sundarbans. Large quantities of *goran* logs are felled every year in the forest and are brought to Calcutta with bark on. These logs are stacked in the open timber yards along the Belliaghata Canal in Calcutta exposed to rain and sun. The rain dissolves and washes off an appreciable proportion of tannin of the bark, and the tannin of the rain-soaked bark also ferments whereby it is partially decomposed and discoloured. This bark stripped from the logs is sold to Calcutta tanners. About two lakh maunds

of it are annually consumed by the local tanneries. Carefully collected samples of *goran* bark have been found to contain about 35 per cent tannin whereas bazar samples do not give more than 20 per cent. It will thus be seen that for the faulty method of collection and stacking of *goran* logs in Calcutta the bark loses much of its tannin content and tanning properties.

Although singly *goran* bark does not produce good leather, it may be used with other tanstuffs such as *babul* bark and myrobalans with advantage. This material is not only rich in tannin but is also very cheap. It is sold from 0-8-0 to 0-12-0 annas per maund (1 maund = 82 lbs.) whereas the price of *babul* bark is from 1-8-0 to 3-8-0 a maund. Besides, the *goran* tannin penetrating the pelt quickly shortens the period of tannage.

Myrobalans (*Terminalia chebula*) is purely an Indian product and used by tanners all over the world. India enjoys a monopoly of this material. The value of its annual export amounts to about 50 lakhs of rupees. The quality of myrobalans differs greatly according to the place of origin. The best grade myrobalans are obtained from the Madras Presidency and are known in the trade as "Salem" myrobalans. Central provinces produce large quantities, which are distinguished as "Jubbulpores". Madras myrobalans are wholly consumed in the tanneries of that province while bulk of the C. P. product is exported. Myrobalans are produced in Bengal but the quantity is small and the quality not very high. Besides the local products, myrobalans are imported from Mayurbhanj, Giridhi and C. P. to Calcutta. The local tanners consume about 90 thousand maunds of myrobalans valued at 1,25,000 rupees annually.

Used singly myrobalans do not produce good leather but they are invaluable as a material for mixing with other vegetable tanstuffs on account of certain characteristics they possess.

Avaram bark (*Cassia auriculata*) is an important tan stuff of India. It grows wild in South India and Rajputana. *Avaram* bark is at present used by tanners in the Madras Presidency in the half tanning of goat and sheep skins for export but in the Bombay Presidency cow hides as well as sheep and goat skins for export are tanned with it. In the half tanning of cow hides and buffalo calf skins for export the Madras tanners now use wattle bark imported from South Africa although at one time *avaram* bark was in use for this purpose.

Wattle bark (*Acacia mollissima*) contains tannin from 30 to 45 per cent averaging about 34 per cent. The cultivation of this species of wattle for the sake

of its bark is one of the principal industries of South Africa. It is an excellent tanning material which is now used practically by all leading tanning countries of the world. Recently the War Supply Board of Government of India has purchased $7\frac{1}{2}$ thousand tons of this bark worth about Rs. 10 lakhs to keep a reserved stock as a safeguard against interruption of or delay in importing the bark due to the present war conditions. Cultivation of wattle trees in India for its bark deserves special consideration. *Acacia mollissima* has been found to grow on the Nilgiri Hills at an altitude of about 7000 ft. from the sea level. The forest department of Madras tried its cultivation near Kodaikanal. Wattle trees also occur in Travancore. The bark from these trees was found to contain 35 to 46 per cent tannin which compares favourably with the average tannin content of the South African bark. Commercial plantation of wattle should, therefore, be vigorously pursued in Madras where it has been proved that the trees can grow. The possibility of its plantation in Bengal may be investigated.

Sonali bark (*Cassia fistula*) contains 10 to 12 per cent tannin and used in Bengal to a certain extent. *Sonali* trees grow in a few places in the province but the bark is not collected on a large scale. When required commercial supplies are obtained from South India where it is known as *konam*. In Calcutta it was once used to a fairly large extent in tanning lizard skins for export but with the decline of this trade consumption of *sonali* bark was considerably reduced. Its use appears to be reviving again since the outbreak of the present war.

MINOR TANSTUFFS

Besides the above, a number of minor tanstuffs are used in the villages in crude small scale tanning. Some of these are barks of *ashan*, mango, sal, guava, *dahua*, *jam* and *amlaki* leaves etc. Use of these materials does not extend beyond local areas and they cannot be exploited on a commercial scale as their supply is not adequate and regular and leathers produced by them are not of the approved commercial standard. Besides the above certain tanning materials occurring in the Sunderban forests have been examined at the Bengal Tanning Institute and found to contain such percentages of tannin as would make them suitable for use as tanstuffs. Although these unexploited tanning materials are not yet really wanted by the tanning industry they are nevertheless potential resources of the province and may prove valuable in emergency.

OTHER TANNING MATERIALS

In modern tanning practice, tanning extracts are being used in increasing quantities because they offer several advantages. In Bengal their use has commenced. At present mimosa extract imported from South Africa, quebracho extract imported from South America and locally manufactured myrobalan extract are used. Myrobalan extract manufactured at the Raneegunge factory is also exported to foreign countries.

A large number of chemicals, dyestuffs, mordants, fat and oil preparations, leather finishing materials such as gums, mucilaginous substances, waxes, gelatine, albumin, pigments, polishes and lacquers are used in the tanning industry. A few of them are locally produced but the majority are imported. The principal chemical used in chrome tanning is bichromate of soda. It may be produced locally from chromite found in Singhbhum district and other places in India. Among other things necessary, sodium sulphide and coal tar dyes deserve special mention. Manufacture of these chemicals and dyes in India is of national importance. Although they require investment of a large amount of capital and big organisations it is essential that these industries are started in the country as early as possible.

MODERN TANNING IN BENGAL

The Western processes of tanning to manufacture those types of leather which satisfy modern tastes and requirements, have been introduced in Bengal both by private enterprise and through Government help. The Bengal Tanning Institute under the Industries Department, has contributed a lot to foster the growth and development of the tanning industry in Bengal on modern lines. The principal chrome tanning centres in India are Calcutta, Cawnpore and Madras producing annually under normal trade conditions $15\frac{1}{4}$, $13\frac{1}{2}$ and 11 million square feet respectively of chrome shoe upper leathers. It will thus be seen that Calcutta is the largest centre of chrome tanning in India. The principal varieties of chrome leather manufactured in India are the following:—

A. Chrome shoe upper leathers.

- (i) Box and willow sides made from cow hides.
- (ii) Box and willow calf from calf skins.
- (iii) Chrome Patent leather from cow hides.
- (iv) Glazed kid from goat skins.
- (v) Glazed sheep skins.

B. Shoe lining leather.

(vi) Natural chrome sheep skins.

C. Chrome sole leather from buffalo hides.

(vii) White chrome sole leather.

(viii) Waxed or proofed sole leather.

D. Industrial leather.

(ix) Chrome picking bands from buffalo hides.

(x) Chrome lace leather from light buffalo or heavy cow hides.

Among these the first named, i.e., box and willow sides, represent bulk of the production both in volume and value. About 3 years ago the total average annual output of this leather in India was about 32½ million square feet valued at about Rs. 90¼ lakhs. The development of the manufacture of this chrome leather in Calcutta during the last 25 years has been phenomenal. About the year 1914 not more than 1½ lakh square feet of this were yearly manufactured in Calcutta. The present output is about 15 million square feet annually, an increase of 100 times. At present on account of the improvement of quality, Calcutta's box sides and box calf are being freely sold in large quantities not only all over India and in the export markets of Burma, Strait Settlements, Iraq, Cyprus, Africa but also in the United Kingdom, in competition with similar leather produced in Europe and America.

Since the Ottawa Agreement of 1932 an export trade in Indian chrome upper leather, chiefly box sides and box calf, has developed. The peak of this export trade was reached in 1937 when 11'714 million sq. ft. of these leathers valued at Rs. 54,13,500 were exported to England from India. The chrome tanneries in Calcutta had considerable share in this trade. At present a number of these tanneries are engaged in this export business. The Bengal Tanning Institute by its researches and training has contributed considerably to this development.

The Bengal Tanning Institute has also worked out a process for the manufacture of a superior type of sole leather from buffalo hides by pit tanning. Besides this leather no other varieties of improved vegetable tanning are as yet manufactured in this province.

The manufacture of chamois leather from goat skins by formaldehyde and oil tannage was introduced in Calcutta chiefly through the experiments conducted at the Bengal Tanning Institute. A

passed student of this Institute is now manufacturing this leather on a commercial scale. The quality of the leather is good and it commands a ready sale.

Alum dressing is used in the dressing of skins of such wild animals as tiger, leopard, deer etc. sent to the taxidermists by *shikaries* and others. Taxidermy is fairly well done in Calcutta.

MARKETING OF LEATHER

As already stated, leathers produced in Bengal are sold in India and also exported abroad. For the Indian market as well as for markets in the overseas countries like Burma, Strait Settlements and Iraq, the distribution is done through Punjabi leather dealers. They purchase from the tanners and sell the leather in the markets. A very small proportion of the leather is sold by the tanners directly to the shoe makers and other consumers of leather.

Some of the large tanneries have their own sales organisations, and those who have middlemen as their selling agents can manage to control them so that they may not go against their interest. The real difficulty is with the small tanners. The middlemen exploit their weakness and the small tanners are often forced to sell their products below cost and are thus eventually ruined. Organisation of co-operative sale and supply societies among small tanners offers a solution of this problem. Such sale societies should undertake selling of Bengal leathers not only in India but also in other principal markets where those are sold. These societies will be able to do away with the middlemen as well as consignment sales in England.

SHOE INDUSTRY

The leather shoe industry in Bengal has developed to the extent of having an annual output worth more than a crore of rupees. But as yet not more than 20% people of the province wear shoes. With the spread of education and rise in the standard of living shoe wearing and demand for leather shoes will gradually increase. To meet the growing requirements of this province alone the industry will have to be considerably expanded. It may also manufacture shoes of a suitable quality for export and sale in the overseas markets. Thus there is a very big scope for the development of this industry in the province.

Another line of development will be manufacture of military and police boots. As yet there is no establishment in Bengal in which this line of

work has been taken up. For the manufacture of army and police boots and shoes the factory must be equipped with modern machinery.

As yet the share of the Bengalees in the shoe industry of the province is very small. The Bengali leather working caste, the *rishis*, having lost all grit and stamina due to poverty have to a very large extent given up shoe making and leather work. The middle-class Bengalee considering it derogatory to pursue shoe making as a profession have always looked down upon it. So there was practically none in Bengal to seek a share of this

growing industry of the province. It was only after facilities were offered for training in the craft with the establishment of Boot and Shoe and Leather Goods Making Department of the Bengal Tanning Institute that the educated *Bhadrolok* youths of Bengal were attracted to this line of business. At present the trained students of the Bengal Tanning Institute are holding a small share in the present shoe industry of the province.*

* Adapted from a lecture delivered at the Calcutta Corporation Commercial Museum on July 20, 1940.

ERRATA

In the article entitled, 'Artificial Fertilizers in Indian Soils', published in the last September issue, on p. 136 please read the sixth line from the bottom of the left column as "2,000 tons per annum are manufactured, according to Sen Gupta (1940), by Messrs." The italicised portion was left out.

In the same issue, in the article entitled, 'India's Industrial Waste: Fusel oil,' in Table III on p. 171 in the third column read the figure for ethyl alcohol from Cawnpore Distillery (U.P.) as 0.57 instead of 5.57.

MEDICINE & PUBLIC HEALTH

Training of Public Health Officers

THE annual report of the All-India Institute of Hygiene and Public Health for the year 1939 reviews modern trends in the training of public health officers. Current thought is increasingly, throughout the world, attaching a much wider significance to the functions of public health. These now imply a study and control of all factors which affect the health of the community. Medical measures alone are insufficient to ensure that the community has or attains a normal standard of health.

The function of investigation and training in public health is the development of the most efficient and practicable methods of scientific medical protection through organized community effort and the provision of opportunity for students to train themselves in the principles and application of those principles and methods. For the provision of opportunity to the students to train themselves and for a study of all the factors covered by the term public health, the necessity for the inauguration of "controlled areas (to permit exemplification of methods) of a size sufficient to provide quality and quantitative facilities for students' self-participation" is emphasised. The development of the most efficient and practicable methods of scientific medical protection through organised community effort can be achieved through research. The absence of controlled community fields however places the Institute under the same disabilities as would be faced by a department of clinical medicine in undertaking research in the absence of a teaching hospital.

The report points out the deficiencies in the present organisation of the Institute and in the curriculum and training and mentions that stress has been laid on the definite requirements of this country in determining the line of reorganisation.

"Public Health", the report points out, "is organised community effort for medical protection, and, as such, is social medicine, the utilisation of which must be different under varying social-economic conditions even although the principles derived chiefly from medical biology are universally

similar. Consequently, it is essential that organisation for instruction and research must vary from country to country during the levelling up process. Malaria must be afforded an importance in India that would be uncalled for in England. Health insurance cannot be given the same prominence in China as in Germany."

An account is given of the progress made in the introduction of reforms in the training of public health officers and mention is made of the proposals under consideration for bringing the All-India Institute up to a standard comparable with similar institutions in other and more advanced countries.

The report goes on to say: "The D.P.H. training should be one of the first educational fields to demonstrate the greater demand for local qualifications in the light of local variabilities in administrative practices. This recognition will be accorded shortly after the students are given adequate practice locally under Indian community conditions".

State Monopoly of Medicine

IN a discussion on State Medicine: Its Proper Sphere, at the Royal Society of Medicine, London, Dr Alfred Cox's argument against making medical service totally a State one was that it would degenerate to the ordinary out-door practice and only "mass medicine", and a proper examination would not be possible. While treating a case, individual attention of a doctor counts much, hence medical attendance is to be left to the profession without being encumbered with any restrictions from outside. He said that the State should be more active with regard to the (a) public health schemes, (b) health insurance schemes, and (c) research work under the universities and research councils. Dr Andrew Topping was very pungent in his remarks and said that the general practitioners practising for about ten years knew less medicine than they did when they had qualified and that in course of their practice they sometimes hoodwinked the public. The consultant branch was also not spared by him. The

pecuniary condition has been at a low ebb and jobbery there is quite rampant. For proper medical work, a medical man should be relieved of his worries for an annual income sufficient to live according to his proper status. Dr Fraub Gray stressed the difficulties which officialdom would bring in the work and hinted that assured income would lead towards slackness in work of the officially employed persons. The general view after the discussion was that some sort of specialist practice should be encouraged and the national insurance scheme should receive more support from the State and should be applied widely as the general health of the people is a matter vitally concerned with the administration of a country.

P. K. C.

Nutrition Research

THE Indian Research Fund Association was formed in 1911 and since then it has devoted increasing attention to the study of nutritional problems and to the practical application of the fruits of such study to the improvement of the diet of the people. Nutrition research has proceeded on the lines of surveys of the state of nutrition and the dietary habits of the people in various parts of the country, the analyses of the common foodstuffs of India for ascertaining their nutritional value, and discovering cheap substitutes in order to meet recognised deficiencies in Indian diets. Rice, as the staple diet in many parts of India, received special attention during 1939, for which year the Report of the Scientific Advisory Board of the Association has recently been released for the public. A memoir entitled "*The Rice Problem in India*", which deals with different aspects of the subject, has been published. The results of over 50 diet surveys in different parts of the country have been embodied in a special publication by the Association and this should prove to be of value to provincial Departments of Agriculture in shaping agricultural policy in order to meet existing diet deficiencies.

The training of health personnel in nutrition work, which was started in 1937, continued in 1939 and seventeen workers from various provinces and Indian States attended a three-months' course. A new edition of Health Bulletin No. 23, entitled "*The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets*" was issued during the year and a nutrition museum was established at the Nutrition Research Laboratories at Coonoor, which is maintained by the Indian Research Fund Association. Researches into different nutritional problems involved investigations in many centres, including

medical colleges in Lucknow and Bombay, the departments of chemistry in Dacca and Calcutta universities, the All-India Institute of Hygiene and Public Health, Calcutta, the Nutrition Research Laboratories Coonoor, and the Imperial Agricultural Research Institute, New Delhi.

Study of Major Diseases

The Malaria Institute of India took a leading part in directing anti-malarial operations and research on scientific lines. The annual class for training in malaria for medical officers from different parts of the country was held at Delhi by the Institute and 24 medical men attended this course. A new health bulletin entitled "*Lectures on Malaria*" was prepared and a new edition of the practical entomological course for medical officers was published.

Plague research is mainly centred at the Haffkine Institute, Bombay. At the Cumbum Valley in Madras Presidency various field studies in regard to the control of epidemic outbreaks of the disease have also been in progress for the past eight or nine years. At the Haffkine Institute as a result of research work on an anti-plague vaccine a serum for the treatment of plague patients had been prepared by this Institute and had undergone limited trials with encouraging results during certain epidemic outbreaks of the disease. At Cumbum Valley the research consisted mainly of work on the prevention of plague by the use of chemicals for rat destruction in rat holes and by the reduction of rat infestation in houses through improved construction.

An investigation was carried out into the existence of varying degrees of disability among the population of certain areas in Madras Presidency as the result of high concentrations of fluorides in the drinking water supplies of those areas.

Researches by field and laboratory studies into leprosy have shown that, in respect of chronic bone and nerve pain associated with leprosy, the adoption of a wheat diet by the patient affords considerable relief. Another important finding is that the administration of skimmed milk to children with the more severe forms of leprosy appears to help towards a cure.

The enquiries supported by grants from the Indian Research Fund Association include most of the major diseases affecting the health of the people of the country. A total sum of nearly Rs. 4,76,000 was distributed during 1939 in the form of grants to the different enquiries.

Some Aspects of Biometry

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A PHYSICAL event, quantitatively described, is produced by the operation of one or more causes. For instance, the weight of a man is causally linked with his heredity, age, occupation, diet and numerous other small factors. Experiment, the tool of the scientist, derives its use from the ability of the experimenter to replace complex systems of causation by simple systems in which only one causal factor is allowed to vary at a time. This is an ideal which is rarely approached in practice. For, consider a problem in nutrition to assess the influence of two different diets on the growth of children as measured by the increase in weight. The subjects of the nutritionist's experiment, namely, children, cannot be brought under complete control in the sense the laboratory conditions like temperature and the like can be controlled. The nutritionist may however try to control his experiment as far as he can by allotting children which are of the same race, religion, caste, sex etc., to the two different diets under consideration or in other words by equalising the two groups in respect of all these factors. He may even ensure that the two groups enter the experiment at the same age, but if he decides that ages of the two groups must be the same, then other factors like the weight etc., will necessarily differ and will affect the differences in the final weights of the two groups. The situation is analogous to the agricultural experiment in which different numbers of plants might grow on two plots equal in area but treated with different manures. The difference in yields of the two plots may here partly be due to the different number of plants grown in the two plots. On the other hand, if the experimenter decides to calculate the yield on equal number of plants, then the areas occupied become different.

It will thus appear desirable to introduce into the experimenter's comparisons of the two yields a correction which makes allowance for the variation in yield due to differences in plant number itself. In precisely the same way, the nutritionist may like to estimate the effect on final results of the differences in initial weights and adjust the final results in accordance with the estimated effects with almost as great an accuracy as if complete equalisation had

been possible in regard to weight. Even so there may be numerous other genetic and personal factors which cannot be measured but which will seriously affect the differences in weights of the two groups. The experimenter cannot possibly eliminate those factors. Even in physics and chemistry the errors of personal observation, of instruments, changes of moisture, etc., cannot be completely eliminated, but they generally form so small a part of the real differences that they can be ignored in arriving at conclusions. The nutritionist cannot afford to do so.

It is with quantitative problem in which the data are affected by numerous causes that the science of statistics is concerned. Its object is two-fold: (i) to build up a statistical design so that valid and conclusive inferences are made possible, and (ii) to interpret the quantitative data of the experiment so that due attention is paid to the influence of the numerous uncontrolled factors. The tool or the method which is considered appropriate to interpret the data in question is called the statistical method. The principles from the consideration of which the method is derived constitute statistical theory and the means by which it is derived is pure mathematics. When the problem under consideration is a biological problem, the science of statistics is said to be biometry.

Whether it is an experiment to assess the difference between different diets given in different quantities and in different environments or an enquiry to estimate the incidence of tuberculosis in the population, the first question with which the statistician is concerned is the planning of the experiment or the enquiry under consideration by which is meant not the drawing and numbering of items in the schedules to suit the requirements of the sorting machine but the structure that will guarantee in the first instance valid inferences through the appropriate process of randomisation and in the second instance greatest accuracy for the results through such devices technically known as that of equalisation, concomitant observations, replication, confounding, stratification and the like. It is not possible to explain here even the rudiments of these principles which constitute what is known

as the science of design of experiments but I shall illustrate later what rôle some of them can play in securing greater accuracy for the results.

It is a historical accident that this science which should have been developed before or simultaneously with the statistical method, actually had its foundation laid much later. The necessity of developing it was always perceived by experimental scientists as will be clear from the following quotation by Robert Boyle in 1673. He writes to his friend, "I am very sorry, that to the many difficulties which you may meet with, and must therefore surmount, in the serious and effectual prosecution of experimental philosophy I must add one discouragement more, which will perhaps as much surprise as dishearten you; and it is, that besides that you will find many of the experiments published by authors, false and unsuccessful, you will meet with several observations and experiments which, though communicated for true by candid authors or undisturbed eye-witnesses, upon further trial, disappoint your expectation, either not at all succeeding constantly or at least varying much from what you expected." This difficulty in experimentation has been all through at the back of the experimenter's mind, but the concepts of inductive reasoning, of arguing from observational facts to the theories which may explain them, such as were developed in those times, were too rudimentary to surmount it. Thomas Bays, the author of the celebrated treatise on inverse probability, was the first to attempt to give an exact quantitative theory of inductive reasoning, but he was never satisfied with the validity of the theory which he put forth. He was so critical of its validity that he never agreed to publish it. It was actually published after his death by his friend Price. To R. A. Fisher goes the credit of laying the theoretical foundation of this science. It was he who first perceived that statistical method and experimental design are only two different aspects of the same whole and that whole is the logical requirement of the complete process of adding to knowledge by experimentation. He outright rejected Bays' "inverse probability." He showed that it could lead one nowhere. He instead proposed a new concept known as likelihood, which is the theoretical foundation of modern statistics.

Having obtained his data and satisfied himself that these are reliable enough to permit him to proceed, the statistician must rearrange them until they are ready for the application of his method. For when we have a large number of values noted merely in the arbitrary order in which they occur, the mind cannot grasp the full significance of the whole record. Some shape of condensation becomes neces-

sary. The most common form of condensation is known as the frequency distribution. Its concept would be clear from figure 1 which shows the frequency distribution of lethal doses of strophanthin. On the horizontal scale of the diagram are marked the lethal doses. On the vertical are marked the number of frogs killed. A lethal dose of '235

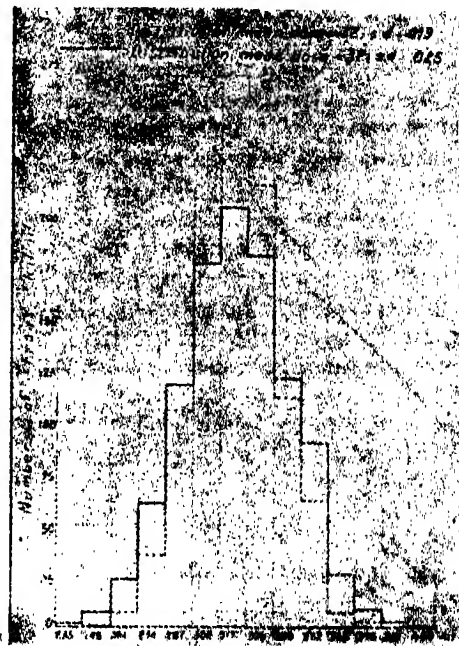


FIG. 1. Illustrating the frequency distribution of lethal doses of strophanthin (indicated on the horizontal scale).

was given to each of 1,000 frogs. As the dose was gradually increased from '235 to '248, two frogs were killed. As the dose was increased from '248 to '261 a further number of 7 frogs was killed and so on. The intervals from '235 to '248 or from '248 to '261 etc., are known as class intervals. The numbers of frogs killed by doses defined by the class intervals are called frequencies. The manner in which the frequencies are distributed over the class intervals is known as the frequency distribution. The diagram shows that the average lethal dose was about '32. It shows that majority of frogs was killed by a lethal dose ranging round about '32. In particular it shows that about 95 per cent of the frogs were killed by a dose ranging from '27 to '37. The diagram shows that as the lethal dose increased or decreased, frequency becomes less and less.

It will be clear that by condensing information in the form of frequency distribution we have got a very necessary clarity about the behaviour of the number of frogs killed with the increase or decrease of lethal doses, but it is also clear that in doing so

we have sacrificed a certain amount of information. For 13 groups cannot possibly replace, thousand different figures without a loss of some information. We shall not however dwell on this point much longer. It is sufficient to remark that while clarity must be gained at the expense of some information, the loss of information is generally negligible if the magnitude of the class-interval chosen is sufficiently small, so that the whole number of frequency-classes lies approximately between 15 and 25.

If the frogs were more homogeneous in their resistance to the dose of strophanthin then the above group of 1,000 would be shown in continuous line. In other words, if the two frogs which were killed by lethal dose of '235 to '248 were less sensible to strophanthin than they actually were or the two

giving a larger value for the average lethal dose. The situation is illustrated in figure 2.

A comparison of the two frequency distributions in the first diagram shows that the two distributions differ in one important respect, namely their variability about the average value or central value. A comparison of the two distributions of the second graph shows that while the shape of the two graphs is identical, the central values are different. Symmetrical distribution are thus seen to differ from each other in two important respects: (i) the central value about which the frequency distribution is scattered, and (ii) the variability of the frequency distribution about its central value.

The central value is commonly measured by what is known as the arithmetic mean, which may be defined as the sum of all the values divided by the number of the values. The variability is measured by what is known as the standard deviation. It is the square root of the variance which is the quotient of the sum of squares of deviations of observations from arithmetic mean by the number of observations. For the two distributions of lethal dose shown in figure 1 the average values are the same, but the variabilities are different, namely '019 and '025. For the distributions in figure 2, the variability is the same, but the average values are different, namely '32 and '33.

With homogeneous material, the frequency distribution generally takes the shape similar to that shown in the diagrams. It is symmetrical on either side of the central value. Most of the distributions we meet with in practice, although they are not quite symmetrical, follow closely the properties given by a symmetrical distribution known as the Gaussian or normal frequency distribution. In the Gaussian distribution about two-thirds of the observations lie between the ranges of arithmetic mean plus and minus the standard deviation, about 95 per cent of the observations lie between the ranges plus and minus two times the standard deviation and less than $\frac{1}{2}$ of 1 per cent lie outside the ranges of arithmetic mean plus and minus three times the deviation.

In any scientific enquiry, we rarely have time and money at our disposal to investigate each and every member of the universe we set out by study. Almost invariably we try to base our conclusions on the basis of sample data. Thus if we want to ascertain the incidence of tuberculosis in the population of Calcutta, we do not examine each and every individual, but try to base our conclusions on a representative sample of individuals of the town. Now if I were to select a sample of 1,000 persons and arrive at a figure x for the incidence of tuberculosis,

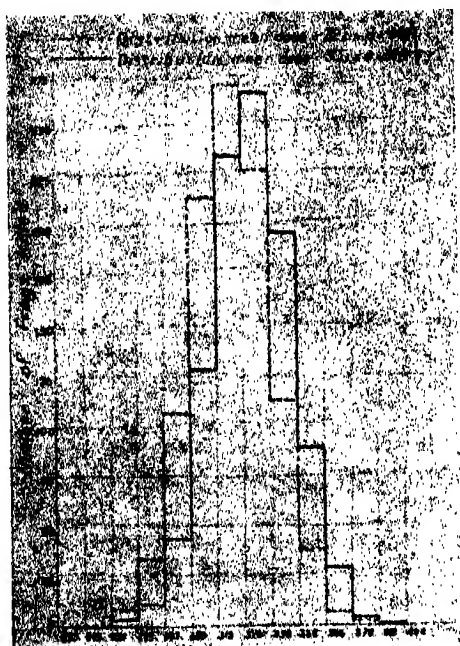


FIG. 2. Illustrating the frequency distribution of modified lethal dose of strophanthin (indicated on the horizontal scale).

frogs which were killed by the lethal dose between '391 to '404 were less resistant, then with the average lethal dose remaining the same, the scattering of the frequency distribution about the average value would be less than that in the first group of 1,000. In other words, variability of the lethal dose in this more homogeneous group of frogs would be less than that in the first group. The situation is clearly depicted in figure 1. In exactly the same way we may have a group of frogs all with uniformly better resistance than those belonging to either of the two groups shown in figure 1 thus

another gentleman selecting his own sample of the same size may not necessarily arrive at the same figure for the incidence of tuberculosis, namely x . Indeed if we take repeated sample of 1,000 individuals the figures for the percentage incidence will vary from sample to sample not because there has been any bias in the selection of samples, but because of the inevitable chance fluctuations which must be present in the selection of different random samples.

The larger the sample, the more is our confidence in the conclusions. Thus if we are to base the figure for the incidence of tuberculosis on a sample of 10,000 instead of on 1,000, anyone would have more confidence in the conclusions from the sample of 10,000, provided of course both are representative samples of the population. The reason for this increased confidence in the conclusions of larger samples in terms of the concept of variability is easily made clear. Repeated samples of 1,000 will show a larger variability in the values of the incidence of tuberculosis than repeated samples of 10,000. We can well imagine the case in which we have investigated the whole of the population resulting in zero variability, for then there will be only one and one figure for the incidence of tuberculosis in the population. Confidence grows in direct proportion to the size of the sample. Alternatively, we may express these results by saying that the accuracy of the estimate for the incidence of tuberculosis varies inversely as the variance or directly as the size of the sample.

Such were the great contributions of Karl Pearson towards the close of the last century, which drew the attention of the scientific world to this subject and gave it the status of an exact science. There was however a significant departure in the way of thinking of Karl Pearson with the entry into the field of two outstanding personalities in statistics, namely W. G. Gossett, who wrote under the pseudonym 'Student', and R. A. Fisher. It was realised that while the accuracy of the estimate arrived from the sample would certainly increase with the size of the sample, it would also be governed by other factors such as the way in which the sample is selected, the method by which the estimate of incidence is made and so on. The former is the sort of problem falling under the category of the design of experiments; the latter under that of estimation.

To illustrate how the accuracy of the result depends on the technique of selecting the sample we may conceive of a population of a town residing in two parts in one of which the incidence is very high and in the other very low. More simply we may

think of estimating the average income of the population and imagine that in one part of the town people drawing exactly the same annual income are living and in the other people of varying incomes from rich to poor are residing. To be specific, let the population of the town be 10,000, of which 3,000 are staying in one part and the remaining 7,000 in the other. If the time and money to estimate the average income is just sufficient to collect a sample of 1,000 then the problem to be considered is how to select a typical sample of 1,000, so that the average income of the whole town will be estimated with the greatest accuracy. A statistician of the older generation would allot equal representation in proportion to the size of the parts of the population. He would argue thus—"if in one part the population is 3,000 and in the other 7,000 then they must select 300 individuals from the first and 700 from the other, thus giving proportional representation." Little consideration will however show that this would be a very unwise selection. If it is known that the variability is zero for the first part of the population, in other words, if it is known that all the 3,000 individuals of the first part have the same income, of what avail would it be to select 300 individuals when one individual is just as good for the purpose? The proper division would be one man from the first group and the remaining 999 from the second. What is true of this imaginary example in which variability is assumed to be zero is equally true of populations in which the variability is different. The allotments of the sample to different strata of the population cannot be governed by the size of the strata but must be made to depend on the consideration of accuracy of the final estimate.

The bearing of the method of estimation on accuracy is stated in general terms as follows. If from a sample of 1,000 observations we calculate an estimate A and a second estimate B having twice the variance of A to estimate, say, the central value of a known, say, normal frequency distribution, then although B might be a valid estimate of the centre it will be one definitely inferior to A in its accuracy. Using the statistic B a sample of 2,000 values would be required to obtain as good an estimate as has been obtained by using the statistic A from a sample of 1,000 values. An example from serology will illustrate the importance of estimation.

The phenomenon known as Land-steiner reaction enables us to classify the blood of individuals into four groups, O, A, B and AB. The characteristics of cells or sera of these blood groups are shown in the following figure. In the group O the cells having no agglutinogens cannot be clumped by any serum, but its serum will clump the cells of all the

other three groups. In the group A, the cells are clumped by sera of groups O and B while its serum clumps the cells of group B and AB. In the group B, the cells are clumped by sera of group O and A while its serum clumps the cells of group A and AB, and lastly in the group AB, the cells are clumped by the sera of all the other groups, but its serum having no agglutinins at all can clump no cells whatsoever. The inheritance of blood-groups, has been explained by Bernstein or what is known as the theory of triple allelomorphs. Bernstein postulates the existence of three genes A, B and R concerned in the blood group formation involving only

haemotype AB. The situation is clearly grasped from table I. On this theory, the haemotypes possible in children of different matings of parents will be as shown in the table II. Thus the mating of parents with blood groups O, O results in a child

TABLE I.

Showing the possible combinations of genes A, B and R and the resulting haemotypes.

	A	B	R
A	A	AB	A
B	AB	B	B
R	A	B	O

with haemotype O, for neither the mother nor the father will carry any other gene except the gene R. In the same way the mating of parents with blood-groups O and A will result in children with blood groups either O or A and so on.

TABLE II.

Haemotypes possible in children in different matings according to Bernstein's Triple Allelomorph Theory.

Mating.	Resulting haemotypes.
O × O	O
O × A	O, A
O × B	O, B
O × AB	A, B
A × A	O, A
A × B	O, A, B, AB
A × AB	A, B, AB
B × B	O, B
B × AB	A, B, AB
AB × AB	A, B, AB

Now if p, q and r denote the frequencies with which the three genes A, B, R are present in the population, it follows that the frequency with which individuals with blood groups O, A, B, AB will occur will be given by the equations set out below

$$O = r^2$$

$$A = p^2 + 2pr$$

$$B = q^2 + 2qr$$

$$AB = 2pq$$

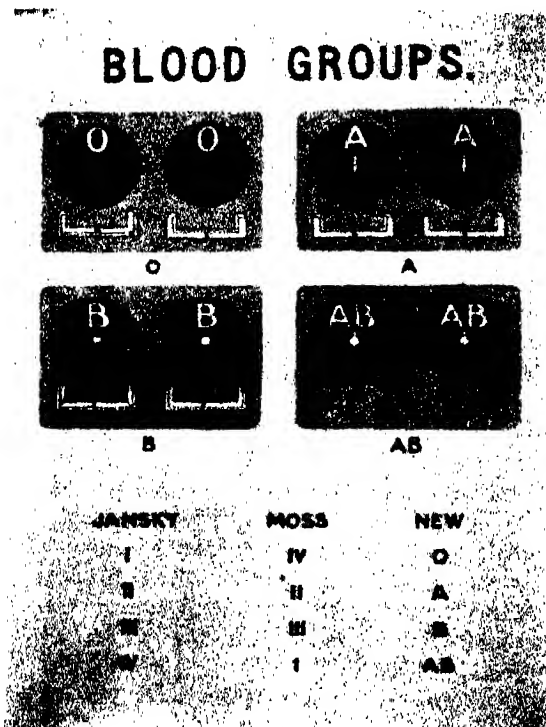


FIG. 3. Illustrating the group-classification of human blood.

one pair of chromosomes. Of the three genes A and B are dominant to R. The presence of the A gene causes the appearance of the A agglutinin on the corpuscles independently of other factors. The presence of B gene causes the appearance of B agglutinin, this also being unaffected by the presence or absence of either A or R. When the two loci are each occupied by an R gene the result is a recessive condition in which neither A nor B agglutinin is present giving haemotype O. If A be present and not B, the haemotype is A. If B be present and not A, the haemotype is B, and if both be present they cause the appearance of respective agglutinin independently, thus resulting in the

We have thus four equations to estimate only three unknowns. The situation is one calling for the use of the theory of estimation. It is analogous to the following problem. If 10 persons investigating the incidence of tuberculosis in 10 parts of Calcutta got 10 different figures for the estimation of the incidence of tuberculosis in their respective parts what will be the best estimate of the incidence of tuberculosis in the whole population. We must combine the figures in such a way that the final estimate will show the least variation or the least variance.

Bernstein gave one set of solutions for the unknowns p , q and r . Later on he gave another set of solutions for the same unknowns, and called the later set of solution as an improved method of estimating the blood groups gene frequencies. He was aware that this later set would show a smaller variation in repeated samples of the same size than the first set of estimation. He thus got two estimates for the unknown r which we might denote by r_1

and r_2 . For r_1 Bernstein found out the sampling variance. For r_2 while he recognised that its variance was smaller than that of r_1 for the same sample size he never actually calculated it. I have shown elsewhere that this variance is about 10 to 12 per cent smaller than the variance of r_1 . The meaning of this finding is explained as follows. From the view point of estimating the R-gene frequency in the population, the time and money spent in examining the blood groups of 12 per cent of the individuals are a pure waste. The force of this argument can be brought home if I illustrate to you what it means in field enquiries like, say, the estimation of the state of nutrition or the incidence of a disease in the population and so on. What one would think if as many as 12 per cent or more of the observations collected can be considered a clear waste from the viewpoint of the object of the enquiry?*

* Adapted from a lecture at the Journal Club, All-India Institute of Hygiene and Public Health, Calcutta.

THEELIN FOR BROKEN BONES

Knitting of broken bones, especially in elderly women, may be speeded by treatment with the female sex hormone, theelin, Dr G. A. Pollock, of the Mayo Foundation, declares as a result of studies of the effects of theelin on broken bones in laboratory animals.

Women over 60 years of age get so-called 'broken hips' with 'striking' frequency, Dr Pollock points out. The condition, although popularly known as a 'broken hip', is actually not a break of the hip but of the neck of the thigh bone near where it is joined to the hip. A change in the bones of older women suggested a relation to the cessation of ovarian function in women past 50 years. Several other scientists, Dr Pollock found, had also noted a relation between female sex hormones and bone formation.

Research Notes

Bacteriophage, its Nature and Behaviour as Studied by the Electron Microscope.

ULTRAMICROSCOPES has been used to investigate the nature of bacteriophage which are too small to be visible by ordinary microscopes. d'Herelle showed that the phage element is first adsorbed on the cell-wall; it then penetrates inside, multiplies and after sometime bursts the cellwall and thus the newly formed phage elements come out. Eisenberg (*Brit. J. Exp. Path.*, 19, 338, 1938) has taken some photo-micrographs of phagelysis of *Coli* bacteria and he supports d'Herelle's 'particulate nature of bacteriophage'. Recently Ruska (*Naturwissenschaften*, Heft. 3, 45, 1940), and Pfankuch and Kanschke (*ibid.*, 46) have taken some photo-micrographs with the help of electron microscopes (Siemens & Halske) at magnifications ranging from 14,000 to 25,000. Ruska has carried out some experiments to study some aspects of phagelysis of *Coli* bacteria. He found that the phage elements are adsorbed on the bacterial membrane and dissolve it after sometime, allowing the plasma to be liberated. The phage elements have been purified from the associated proteins obtained from bacteria and the culture medium by adsorption and elution from aluminium hydroxide C, γ . The size of the phage corpuscles has been measured to be 40—80 m μ . in diameter (this has also been established by Andrews and Elford, *Brit. J. Exp. Path.*, 13, 446, 1932 by their diffusion experiments). From experiments on highly purified phage samples they postulate that the phage elements are associated with high molecular proteins and this is in agreement with the ultra-centrifugal experiments of Northrop (*J. Gen. Physiol.*, 21, 335, 1938) and Wyckoff (*ibid.*, 367) and with the chemical analysis of Schlesinger (*Lancet*, i, 818, 1935). They have further found that during protracted irradiation the phage corpuscles are destroyed by the electrons leaving only some hollow round bodies.

D. K. R.

Indication of a New Chick Growth Factor in Rice

HOGAN and his co-workers (*Jour. Biol. Chem.*, 64, 113, 1925) suggested that polished rice contains a chick growth factor not present in any significant amount in yeast. MacFarlane *et al* (*Jour. Nutrition*, 4, 331, 1931) supported this observation. Stokstad and Manning (*Poultry Science*, 18, 413, 1939) studied this problem and found that polished rice has a growth-promoting effect which cannot be provided by levels of dried yeast up to 15 per cent of the ration. Very recently Almquist, Stokstad, Mecchi and Manning (*Jour. Biol. Chem.*, 134, 213, 1940) have found that glycine is required in the diet for optimum growth of the chick. When adequate glycine is present in the diet chondroitin has a growth-promoting action on the chick. A combined effect of glycine and chondroitin can replace the "rice factor".

A. C. M.

The Iron of the Plasma.

THE iron content of the plasma probably plays a very important part in the transport of iron. Much work has been done regarding the nature of the iron present in the plasma. Barkan (*Klin. Wschr.*, 16, 330, 1935) has shown that the plasma iron is present in the ferric state and is non-extractable with trichloroacetic acid but becomes easily extractable if the plasma is incubated with dilute HCl at 37° for 24 hours previous to extraction.

Tompsett (*Biochem. Jour.*, 34, 959, 1940) has confirmed the work of Barkan and states that probably the iron is present in the plasma in complex combination with phosphatides which prevent the ultrafiltration of the iron. But it has been shown that if the plasma is acidified and allowed to stand the Fe becomes reduced to the ferrous state, probably by the plasma protein, and becomes ultrafiltrable. So, according to the author, the plasma Fe will, at least in part, be changed into the ferrous state before being utilizable.

K. C. S.

BOOK REVIEW

Scattering of Light and the Raman Effect—by S. BHAGAVANTAM. Published by the Andhra University, Waltair, 1940. Pp 333+x, with 2 plates and 41 figures. Price Rs. 15/- or 22sh.

This book deals with the experimental details as well as theoretical treatment of various problems in classical scattering of light and of the Raman effect. The author is a well-known worker in these lines of research and was one of the collaborators of Prof. Sir C. V. Raman for a number of years. It is well known that the intensive study of various aspects of scattering of light by Prof. Sir C. V. Raman and some of his collaborators has not only resulted in important and valuable contributions to the present state of our knowledge of the subject but has also led to the discovery of the Raman effect. This effect has found its application in various branches of science and a large volume of literature has accumulated during the last twelve years, and a large part of this literature has been contributed by the discoverer himself and his collaborators. Before the publication of this book there was not a single treatise in English giving a connected detailed account of the experimental and theoretical aspects of both the unmodified scattering and the Raman effect. The famous article of Placzek in *Handbuch der Radiologie*, Band 6, Part II, 1934, deals with the theoretical aspects of this subject quite thoroughly, but it is written in German and the experimental details have been omitted. The publication of this book has therefore removed a long felt want. This book will be useful to the Post-Graduate students who have to study this subject, as well as to beginners in researches in these lines.

The first eight chapters of the book deal with the theory and experimental details regarding Rayleigh scattering by anisotropic molecules in the gaseous state, by liquids, amorphous solids and by liquid mixtures and liquid boundaries. The experimental results have been discussed in the light of these theories. Chapter VII has been devoted to an account of the theoretical attempts which have been made so far to calculate the anisotropy of molecules in certain crystals and of some diatomic molecules in the gaseous state. Chapter IX deals with the classi-

cal theories of some allied optical phenomena, e.g., natural, mechanical, electric and magnetic birefringence in which the optical anisotropy of the molecules plays an important role.

The remaining nine chapters deal with the Raman effect, its theory, experimental arrangements and results, and its application to various subjects. Chapters XI and XII deal with the theory of vibrational and rotational Raman scattering and are based on the theories put forward by Placzek and by Placzek and Teller. The relation between selection rules for Raman scattering and the symmetry of the molecules as originally given by Placzek in his article mentioned above has been treated lucidly in Chapter XII. Chapter XV dealing with the experimental technique is quite useful. As regards the discussion of experimental results, it is difficult for any author to do justice to such a large amount of data which has accumulated. So, although attempts have been made in the book to classify these results on the basis of the nature of the different problems which have been solved by the application of the Raman effect, some interesting results have been overlooked by the author in discussing a few of the applications. Chapter XVIII dealing with Raman effect in relation to organic chemistry is by no means an exhaustive account of the work done so far on this particular topic, but attempt has been made to refer briefly to most of the aspects of this particular topic.

There are seven useful appendices at the end of the book dealing with "radiation from moving charges", "convergence correction", "fluctuations", "evaluation of the various matrix elements of the polarisability tensor", "tensor components and their transformation from one co-ordinate system to another", "groups and group characters" and "group theory and normal oscillations of molecules".

The printing is quite satisfactory, the letters being of fairly big size and the paper (Esparto Imperial Octavo) being of good quality. There are about forty-two line blocks and two plates. Considering the increase in the cost of materials in printing the book during the war-time, the price of the book is quite moderate and it is hoped that the

book will have wide circulation both in India and abroad.

S. C. Sirkar.

An Attempt at the Correlation of the Ancient Schistose Formation of Peninsular India—by

SIR LEWIS L. FERMOR. (*Memoirs. G. S. I. Vol. 70, Pt. 2. No. 2, 1940*).

Sir Lewis Fermor has been given a heavy responsibility and arduous task of writing an account of the correlation of the ancient schistose formations of Peninsular India—a subject of very great importance in Indian stratigraphy. Two issues have already appeared and the present one under review is the third of the series and the entire subject will perhaps be covered by several more yet to be published. These publications appear to be very valuable as they come from the pen of one who has devoted his life to the study of the older formations of India. In these publications the works of the other officers of the G. S. I. have also been taken into account. Amongst other things Mr West's important work on origin of streaky gneisses of Nagpur area and Deolapar nappe structure has aptly been mentioned herein.

The present volume deals only with the Sausar-Balaghat Province of the non-chaonockitic region. This province is occupied by granulites, marbles, quartzites, schists and phyllites, in general parallel banding with ortho-gneisses, paragneisses, composite gneisses and also with intrusive granites and pegmatites. The rock units comprising this Archaean terrane have been divided into two main groups, namely (i) the rocks of presumed Dharwarian age that are mainly or entirely of sedimentary origin, and (ii) the ortho-gneisses and granulites.

There is a great difference between the intensity of metamorphism in two sections of the province, the western end being so highly metamorphosed that it has proved exceedingly difficult in many cases to separate the metamorphosed sediments from the metamorphosed igneous rocks. Close mapping has however led to the separation of the stratified succession under the term Sausar Series, which include several stages consisting of calc-granulites, marbles and calciphyres with manganese ores, mica gneisses, biotite-sillimanite schists with gondite series, and manganese ores, chlorite schists, dolomite marbles with serpentine, spinel, diopside etc., hornblende schists, garnet amphibolites, pyroxenites, chlorite schists etc. In the eastern section the grade of metamorphism is so much less intense that sedimentary and igneous units are clearly distinguishable and in fact have always been mapped separately and the metamorphosed sediments have been known

as the Chilpi Ghat Series composed mainly of micaceous phyllites with quartzites and manganese ores and some greenstone.

The ortho-gneisses have been sub-divided into: (i) Granodiorite biotite-gneisses and porphyritic and augen-gneisses, (ii) Streaky gneisses due to introduction of aplitic material into (i) and into schistose members of the Sausar Series. This has been clearly proved by West, and (iii) Later granites and pegmatites, including the fine-grained Anula granite.

All these gneisses are younger than the Sausar Series and no basal conglomerate to the Sausar Series has been found, nor the floor upon which this series was deposited.

The problem whether the Sausar Series and the Chilpi Ghat Series are contemporaneous was discussed by Fermor and the nature of the conglomerates of the Chilpi Ghat Series and the similarity of petrographical peculiarities of the rocks of the two series have also been taken into due consideration. From these evidences Fermor has accepted that the Chilpi Ghat and Sausar Series are two aspects of the same period of deposition. The interpretation that has been put upon this conglomerate does not however appear to be very convincing and some more detailed field work may throw sufficient light on this problem.

Fermor has also accepted the Sakoli Series as the equivalent of the Chilpi Ghat Series. He also suggests that the Sakoli beds are mainly higher in the succession than the Sausar Series, with possibility of a separating plane or zone of movement with downthrow of the Sakoli rocks relative to the Sausar rocks. On this interpretation the Chilpi Ghat Series which is equivalent both to the Sausar Series and to the Sakolis must have a longer upward range than the Sausars.

On the lithological grounds Fermor suggests the following correlation with rocks in other parts of India:

- (a) The gonditic rocks and associated manganese-ores of the Nagpur-Balaghat area with the gonditic rocks of the Gangpur series in the Singhbhum-Orissa Province, and of the Aravalli series in Narukot and Jhabua States in the Rajputana-Gujarat Province; and also with the manganese-garnet-bearing rocks of Sakrasanhalli in Mysore.
- (b) The black mangiferous limestone (Lohangi stage) of Devi in Chhindwara district with the black mangiferous limestone of Sakrasanhalli in Mysore.
- (c) The calc-granulites (Utakata stage) of the Sausar Series with the taurites of Mysore.

- (d) The hornblende-schists of Sitapar with the hornblende-schists of Mysore.
- (e) The schists and streaky gneisses of the Nagpur-Balaghat area with portions of the Peninsular gneiss of Mysore.
- (f) The phyllites and schists of the Chilpi Ghat series with rocks of similar character in the Sakoli series of the Chanda-Bastar Province, and with similar rocks in the Dharwars of the Dharwar-Mysore-Nellore Province.
- (g) Allowing for differences of grades of metamorphism Fermor is tempted to correlate the gonditic rocks, manganese-ores and associated schists, marbles and calc-granulites of the Sausar Series, with the koduritic rocks, manganese-ores, khondalites, marbles and calc-granulites of the Eastern Ghats Province.

According to Fermor there appears to be little doubt that in general both the Sausar Series and the Chilpi Ghat Series may be regarded as equivalent to the Dharwars of South India. But on account of the lateral changes of character of the Dharwars, he finds it rather difficult to effect any precise equation of sections of the Sausars or of the Chilpis with occurrences in the Dharwar-Mysore-Nellore Province. He also admits that it is also difficult to equate the relatively small occurrences of hornblende-schist of the Sitapar stage of the Sausar Series with the much larger developments of hornblende-schists in Mysore. These intricate problems relating to detailed correlation of the ancient schistose formations occurring at several places in Peninsular India have yet to be solved by future workers.

N. N. Chatterjee.

A Student's Book on Soils and Manures—by SIR

E. J. RUSSELL, D.Sc., F.R.S., Director of the Rothamsted Experimental Station. 3rd Edition. Published by Cambridge University Press, 1940. Pp. 296 with index. Price 8s. 6d. net.

The book is familiar to all students of agricultural science as also to teachers and research workers. It is no exaggeration to say that Sir E. J. Russell, through his books and writings, has acted for a generation as a teacher of agricultural science throughout the English-speaking world. His simple and easy style combined with authenticity of the information make his writings so attractive and fruitful. This book first appeared in 1915. It has been revised and rewritten for the present edition. As stated in the preface, the author has "endeavoured

to steer a straight course between the elaboration which most students would find unnecessary and the over simplification which often leaves the student with a good deal to unlearn if he proceeds to a fuller study of the subject." A student often finds it necessary but greatly difficult to unlearn much of what he has learnt through an unhappy choice of books. Not many are in a position to write books bearing on the subject matter of the present one and avoid at the same time the pitfalls. It is really wonderful to find how much reliable, up to date and balanced information has been compressed in lucid and easy language within the compass of the 290 pages of the small book. The book will be indispensable for students and teachers of the subject. The book has been mainly written for the students in Britain, much of its contents is however useful for students in other countries. One cannot help comparing the information relating to soil conditions in Britain which can be placed before a student, with that relating to Indian soils, their management and treatment with manures and fertilisers which can be utilised for teaching. There is no single publication which would convey a general idea of Indian soils and the results of treating them with fertilisers and manures. The dearth of authentic information and the immature nature of many experiments are undoubtedly in part responsible for this state of affairs. Besides, advisory work has scarcely yet been undertaken in any concrete form by the Indian Agricultural Departments. The Indian student can only envy his British compatriot.

The book is divided into four parts. Part I gives an account of the soil under the heads ; what the plant needs from the soil ; the composition of the soil ; the organic matter of the soil and the changes it undergoes ; the effect of climate on the soil and on fertility. Part II deals with the control of the soil under the heads ; cultivation and the control of soil fertility. The latter naturally constitutes the largest chapter in the book. Part III deals with fertilisers under the heads ; the food of plants ; the nitrogenous fertilisers ; the minor elements of plant nutrition ; manures supplying organic matter (the simpler organic manures) ; organic manures supplying plant food and humus, farmyard manure, composts, town refuse ; chalk limestone and lime ; manurial schemes for crops. There are appendices dealing with (i) field experiments using the modern statistical technique ; (ii) some useful data ; (iii) fertiliser substances contained in crops ; and (iv) books and references on soils and crops for further study.

As already stated the book is indispensable to teachers and students alike.

J. N. M.

LETTERS TO THE EDITOR

High Frequency Properties of Soil.

In view of the future expansion of radio in India a complete survey of the high frequency properties of soil throughout the country is very necessary. For a better understanding of the nature of the H.F. properties of soil, such soil surveys are generally extended up to ultra-short waves. Very few observations^{1,2}, however, have been reported so far. Recently some experiments have been started in this laboratory for the measurement of the dielectric constant and conductivity of different kinds of soil for different frequencies and under different conditions. Some preliminary experimental results and a few points emerging therefrom are contained in the present note.

While the measurement of above mentioned properties of soil for medium and short waves by the usual direct methods do not present much of experimental difficulties, the same is not true for ultra-short waves. In the latter case the sources of error become more numerous. The amount of error was found to be as high as 20 per cent in the experimental results obtained by Rose-Smith.³ An alternative method was, however, suggested by him and Mcpetrie⁴, in which the actual length of the ultra-short waves are measured over a pair of Lecher wires which was immersed in soil contained in a wooden box. This method with certain modifications was used by Banerjee and Joshi¹ and also by Chakravarty and Khastgir,² for the measurements of the dielectric constant and conductivity of soil. Adopting the same method the dielectric constant and conductivity of a sample of local soil were determined for different moisture contents. The results are shown in figures 1 and 2 by means of graphs B and C respectively. These values were obtained for a wavelength of 4.45 meters.

During the performance of these experiments, it was realised by us that in spite of the simplicity and other advantages of this method, it cannot be very convenient when making a survey of soil properties

over largely extended areas, as the amount of soil required in this method is considerably large. Further, the process of sieving, drying and packing of such large quantities of soil would not only take considerable time but may be very often unsatisfactory. With this point in view attempts were made

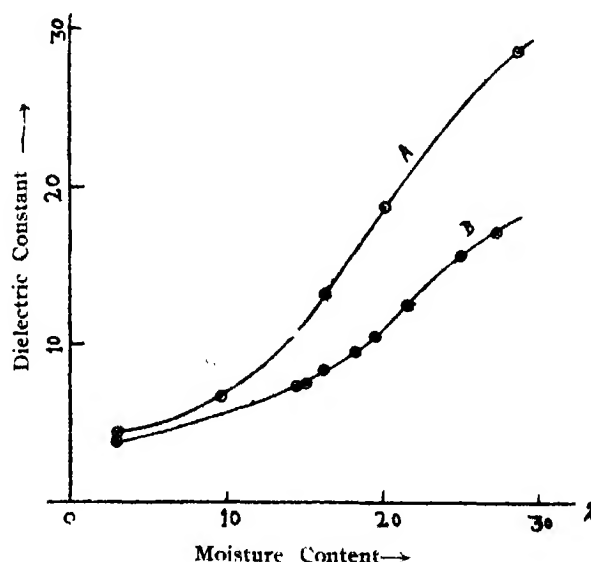
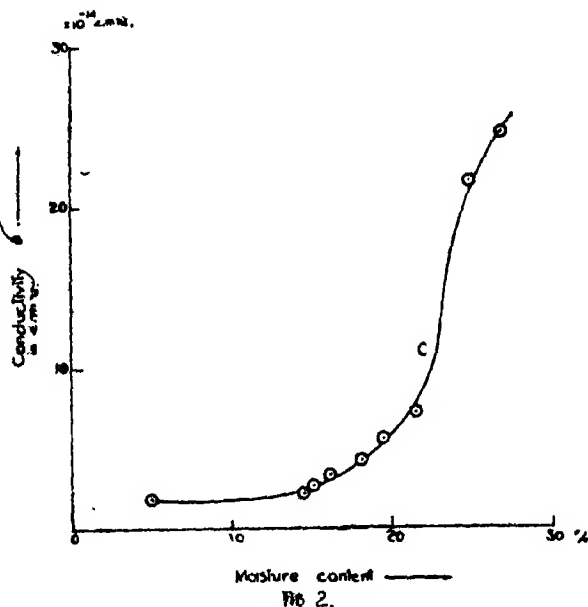


FIG. 1.

by us to measure the dielectric constant of soil for ultra-short waves by the direct measurement of the capacity of a specially designed condenser when empty and also when packed up with soil. The leads of the condenser were kept as small as possible, and whatever capacity they possessed, could be measured fairly accurate by removing the plates from the leads. For the measurement of all the capacities a pair of Lecher wires of suitable diameter and separation was used. The experimental value of condenser was found to agree closely with that calculated from its dimensions. This was further checked by filling the condenser with distilled water. The condenser was connected at the ends of the

Lecher wires and the various capacities were calculated from the measurements of the shifts in the resonance positions. Errors due to corresponding changes in inductance were found to be considerably small. The experimental values of dielectric constant of the same sample of soil as used in the first experiment, for different moisture contents are shown by means of graph A in fig. 1. The wavelength used was 4.45 meters.



It will be seen that the values of dielectric constant obtained by this method are higher than those obtained by the previous one and the increase is greater for higher moisture contents. This difference in the two results may be due to the fact that in the previous method the soil was not packed to maximum capacity and the distribution of moisture was not uniform throughout the entire mass of soil. Further, in spite of best arrangements, when sliding the contact over the Lecher wires for the measurement of wavelength, soil was disturbed to some extent.

Independent experiments were also performed to see the effect of packing on the value of dielectric constant. For fairly dry soil, starting with very loose packing the maximum capacity was reached and the corresponding increase was found to be about 20%. For soil of higher moisture contents the increase in the value of dielectric constant was found to be much greater.

Further investigations are in progress. We are grateful to Prof. K. Prasad, B.A. (Cantab.), for

giving us every facility in carrying out the present work.

Physics Laboratory,
Science College,
Patna, 1-8-1940.

S. P. PRASAD
B. N. SINGH
BASUDEO SINHA.

¹ Banerjee, S. S. and Joshi, R. D., *SCIENCE AND CULTURE*, 2, 587, 1936-37. See also, *Phil. Mag.*, 25, 1025, 1938.

² Chakravarty, K. and Khastgir, S. R., *Phil. Mag.*, 25, 793, 1938.

³ Smith-Rose, R. L., *Proc. Phy. Soc.*, 47, 923, 1935

⁴ Smith-Rose, R. L. and Mcpetrie, J. S., *Proc. Phy. Soc.*, 46, 649, 1934.

The Distribution of the Mean for Certain Bessel Function Populations

McKay (1932) had shown that the Bessel Function Distributions

$$p_1(x) = C_1 e^{-\frac{c}{b}x} \left| x \right|^m I_m \left| \frac{x}{b} \right|, \quad (1)$$

where

$$C_1 = \frac{2\sqrt{\pi} (c^2 - 1)^{m+\frac{1}{2}}}{(2b)^{m+1} \Gamma(m+\frac{1}{2})},$$

and

$$p_2(x) = C_2 e^{-\frac{c}{b}x} \left| x \right|^m K_m \left| \frac{x}{b} \right|, \quad (2)$$

where

$$C_2 = \sqrt{\pi} \frac{(1 - c^2)^{m+\frac{1}{2}}}{2^m b^{m+1} \Gamma(m+\frac{1}{2})},$$

were suitable for graduation in a definite region of the Pearsonian β_1 - β_2 plane. It is to be noted that (1) is to be used when $|c| > 1$, and further that if $c > 0$, x is to lie between 0 and ∞ and if $c < 0$, x is to lie between $-\infty$ and 0. Similarly (2) is to be used when $|c| < 1$ and in that case x is permitted to range from $-\infty$ to ∞ . It is also to be noted that b is a positive constant and $(m + \frac{1}{2}) > 0$.

It might be mentioned that both in (1) and (2) only the index of the exponential term changes sign with x .

It has recently been found by the author of the note that the type of the distribution is conserved when we proceed to the distribution of the mean of samples from (1) and (2). This follows immediately by the use of the method of characteristic functions.

For (1), the characteristic function of the distribution law of x is given by

$$C_1 \int_0^\infty i t x - \frac{c}{b} x \cdot x^m I_m \left(\frac{x}{b} \right) dx = \left[\frac{c^2 - 1}{(1b - c)^2 - 1} \right]^{m+\frac{1}{2}} \quad (3)$$

The characteristic function of the distribution law of the mean \bar{x} of a sample of size n is, therefore given by

$$\left[\frac{n^2 (c^2 - 1)}{(itb - nc)^2 - n^2} \right]^{\frac{2mn+n}{2}} \quad (4)$$

whence it is apparent that the distribution law of \bar{x} is

$$p_1(\bar{x}) = C_1 e^{-\frac{nc}{b}\bar{x}} (\bar{x})^{\frac{2mn+n-1}{2}} \int_{2mn+n-1}^{\infty} \left(\frac{n\bar{x}}{b} \right)^{\frac{nx}{b}} \quad (5)$$

where

$$C_1 = \frac{2\sqrt{\pi} (c^2 - 1)^{\frac{2mn+n}{2}}}{\left(\frac{2b}{n} \right)^{\frac{2mn+n+1}{2}} \Gamma\left(\frac{2mn+n}{2} \right)}$$

In the same way the characteristic function of the distribution law of \bar{x} for (2) is

$$C_2 \int_{-\infty}^{\infty} e^{itx - \frac{c}{b}x} x^m K_m\left(\frac{x}{b}\right) dx = \left[\frac{1 - c^2}{1 - (ibt - c)^2} \right]^{n+1} \quad (6)$$

Hence the characteristic function of the distribution law of the mean \bar{x} , of the sample of size n is given by

$$\left[\frac{(1 - c^2) n^2}{n^2 - (ibt - n)^2} \right]^{\frac{2mn+n}{2}} \quad (7)$$

and the distribution law of \bar{x} is, therefore, given by

$$p_2(\bar{x}) = \bar{C}_2 e^{-\frac{nc}{b}\bar{x}} (\bar{x})^{\frac{2mn+n-1}{2}} K_{\frac{2mn+n-1}{2}}\left(\frac{n\bar{x}}{b}\right) \quad (8)$$

where

$$\bar{C}_2 = \frac{2(1 - c^2)^{\frac{2mn+n}{2}}}{\sqrt{\pi} \left(\frac{2b}{n} \right)^{\frac{2mn+n+1}{2}} \Gamma\left(\frac{2mn+n}{2} \right)}$$

It may incidentally be noted that if c is made zero and b unity in (2) we get Karl Pearson's well-known $T_m(x)$ function, viz.

$$T_m(x) = \frac{1}{\sqrt{\pi}} \cdot \frac{1}{2^m} \cdot \frac{1}{\Gamma(m - \frac{1}{2})} x^m K_m(x) \quad (9)$$

and, it follows immediately from (6) that

$$T_m(x) = \frac{1}{\sqrt{\pi}} \cdot \frac{1}{2^m} \cdot \frac{1}{\Gamma(m - \frac{1}{2})} x^m K_m(x) \times K_{\frac{2mn+n-1}{2}}\left(\frac{n\bar{x}}{b}\right) \quad (10)$$

Statistical Laboratory,
Presidency College,
Calcutta, 8-8-1940.

M. P. SHRIVASTAVA

¹ McKay, A. T., *Biometrika*, 24, 39, 1932.

² Karl Pearson and Others, *Biometrika*, 21, 184, 1929.

Vitamins B₁ and B₂ content of *Ata* (whole wheat flour), White Flour, and *Suji* (Semolina)

Vitamins B₁ and B₂ contents of a few samples of bread have already been investigated in this Laboratory¹. Recently we have determined the vitamin B₁ and B₂ content of *ata*, white flour and *suji*. In the estimation of these vitamins the biological method of assay with young albino rats as described by Guha and Chakravorty² was employed.

Five rats of each group, deficient in vitamins B₁ and B₂ respectively, were fed with *ata*, white flour and *suji* respectively, in 2 grammes daily dose, for 3 weeks and their average weekly growth was determined. The substances were produced from the local co-operative stores.

The results of the experiments, in terms of the units of vitamins B₁ and B₂ as defined by Guha and Chakravorty³ are given in the following table:

Substances Tested	Units of Vitamin B ₁	Units of Vitamin B ₂
White flour	68.5	66.0
<i>Ata</i>	50.3	32.0
<i>Suji</i>	33.5	5.0

From the table it is evident that from the standpoint of vitamins B₁ and B₂, *ata* is an exceptionally rich substance. The vitamin B-content of white flour too is of a high order and both the articles contain a much greater amount of vitamins B₁ and B₂ than the unboiled rice⁴. The vitamin B₂-content

of *suji* has however been found to be negligibly small.

My sincere thanks are due to the authorities of this firm for their help and encouragement in the work.

Biochemical Laboratory,
Bengal Chemical & Pharmaceutical Works, Ltd.,
Calcutta, 5-9-1940.

H. G. Biswas

¹ Biswas, SCIENCE AND CULTURE, 4, 361, 1938-39.

² Ind. Jour. Med Res., 20, 1045.

³ Ibid., 21, 221.

⁴ Biswas, SCIENCE AND CULTURE, 2, 272, 1936-37.

Radiation Laws and the Enumeration of the Wave-Functions for a Continuum.

In the usual derivation of the radiation laws the number of wave-functions lying in the frequency range $\nu, \nu + d\nu$ or the wave-length range $\lambda, \lambda + d\lambda$ for a continuum of volume V is taken to be

$$a(\nu)d\nu = 2 \frac{4\pi\nu^3 V}{c^3} d\nu. \quad (1)$$

$$a(\lambda)d\lambda = 2 \frac{4\pi V}{\lambda^4} d\lambda.$$

These, however, are asymptotic expressions (though this point is not often clearly stated). The problem of enumerating the wave-functions for a continuum more accurately than given by (1) has received a good deal of attention in recent theoretical literature¹ on architectural acoustics, and though no general solution is available, in the case of a cubical enclosure the value of $a(\nu)d\nu$ or $a(\lambda)d\lambda$ to a third approximation is

$$a(\nu)d\nu = 2 \frac{4\pi\nu^3 V}{c^3} d\nu \left\{ 1 + \frac{c}{8V^{1/3}\nu} + \frac{c^2}{8\pi V^{2/3}\nu^2} \right\}. \quad (2)$$

$$a(\lambda)d\lambda = 2 \frac{4\pi V}{\lambda^4} d\lambda \left\{ 1 + \frac{\lambda}{8V^{1/3}} + \frac{\lambda^2}{8\pi V^{2/3}} \right\}.$$

The replacement of the expression (1) by the more exact expression (2) will introduce corresponding small correction-terms in the radiation laws. Taking Stefan's law, if u denotes the energy-density of the total radiation in a (cubical) enclosure of volume V and at a temperature T , we have,

$$uV = \int_0^\infty \frac{a(\nu)d\nu \cdot h\nu}{e^{h\nu/kT} - 1}$$

and on substituting (2) and integrating

$$u = \frac{48\pi k^4 T^4}{h^3 c^3} \zeta(4) \left\{ 1 + \frac{1}{24} \frac{\zeta(3)}{\zeta(4)} \frac{hc}{kTV^{1/3}} + \frac{1}{48\pi} \frac{\zeta(2)}{\zeta(4)} \times \left(\frac{hc}{kTV^{1/3}} \right)^2 \right\} \quad (3)$$

where $\frac{hc}{k} = 1.43$, and $\zeta(s)$ is the Riemann-Zeta function.

It will be noticed that the energy-density is strictly not an *intensive* quantity, for it depends on the volume, this dependence disappearing only in the limit of $\frac{hc}{kTV^{1/3}} \rightarrow 0$. The correction to Stefan's law (as usually stated) is, as is evident from (3), (4), ordinarily negligible, but will be appreciable for low temperatures; and it is interesting at least from a theoretical point of view to observe that at extremely deep temperatures we have a wild departure from the usual fourth-power law.

Lest the above discussion should appear to be rather disconcerting in view of the supposed thermodynamical proof of the fourth-power law, it may be remarked that the thermodynamical proof as usually given of the fourth-power law involves the assumption

that $\left(\frac{\delta u}{\delta V} \right)_T = 0$. When this assumption is not made we obtain

$$4u = T \left(\frac{\delta u}{\delta T} \right)_V - 3V \left(\frac{\delta u}{\delta V} \right)_T \text{ or } u = aT^4 f(TV^{1/3}) \quad (4)$$

where a is constant and f is arbitrary. Equation (3) is in accordance with (4).

Physics Department,

University of Delhi.

Delhi, 25-8-1940.

D. S. KOTHARI

¹ R. H. Bolt, Jour. Acous. Soc. (America), 10, 228, 1939.

² Dah-You Maa, Ibid., 10, 235, 1939.

³ E. L. Hill, Amer. Jour. Phys., 8, 158, 1940.

Also see K. Husimi, Proc. Phys.-Math. Society (Japan), 21, 759, 1939.

Debye's Theory of Specific Heat and the Enumeration of the Wave-Functions for a Continuum

In a previous communication¹ to this journal the effect of a more exact enumeration of the wave-functions for a continuum on Stefan's fourth-power law has been considered. In the present note the discussion is extended to Debye's T^3 -law² for the specific heats of solids. The number of normal modes of vibration lying in the frequency range

$\nu, \nu + d\nu$ for an isotropic solid in the form of a cube of volume V is to a third approximation

$$a(\nu)d\nu = \frac{4\pi\nu^3 d\nu}{c_1^3} V \left\{ 1 + \frac{c_1}{8V^{1/3}\nu} + \frac{c_1^2}{8\pi V^{1/3}\nu^2} \right\} + \frac{8\pi\nu^3 d\nu}{c_2^3} V \left\{ 1 + \frac{c_2}{8V^{1/3}\nu} + \frac{c_2^2}{8\pi V^{1/3}\nu^2} \right\}, \quad (1)^*$$

where c_1 is the velocity of longitudinal waves and c_2 for transverse waves. The total energy of the solid (cube) for all possible modes of vibrations is

$$U = \int_0^{\nu_m} \frac{a(\nu) \nu}{e^{h\nu/kT} - 1} d\nu, \quad h\nu_m = k\theta, \quad (2)$$

where θ is the Debye-characteristic temperature, and

$$\text{is given by Debye's assumption } 3N = \int_0^{\nu_m} a(\nu) d\nu, \quad (3)$$

where N is the number of particles. Differentiating U with respect to T for constant volume, we have

$$\left(\frac{\delta U}{\delta T}\right)_V = \frac{4\pi k^4 T^3 V}{15 h^3} \left[\frac{\xi^4 e^\xi}{(e^\xi - 1)^2} \left\{ \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) + \frac{h}{8kTV^{1/3}} \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \frac{1}{\xi^2} \right\} \right. \\ \left. + \frac{h^3}{8\pi k^3 T^3 V^{1/3}} \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \frac{1}{\xi^2} \right], \quad (4)$$

$$\text{where } \xi = \frac{h\nu}{kT}.$$

Restricting ourselves to very low temperatures i.e., $\theta/T \rightarrow \infty$, we have on integration

$$\left(\frac{\delta U}{\delta T}\right)_V = \frac{4\pi k^4 T^3 V}{15 h^3} \left[\frac{1}{15} \xi(4) \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) + \frac{h}{8kTV^{1/3}} \frac{1}{15} \xi(3) \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) + \frac{1}{8\pi} \left(\frac{h}{kTV^{1/3}}\right)^2 \frac{1}{15} \xi(2) \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \right], \quad (5)$$

where $\xi(s)$ is the Riemann-Zeta function.

* This corresponds to equation (1) of the previous note.

The integration of equation (3) gives us

$$\frac{9}{4\pi} \frac{N}{V} \left(\frac{h}{k\theta}\right)^3 + \left[\left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) + \frac{3}{16V^{1/3}} \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \frac{h}{k\theta} + \frac{3}{8\pi V^{1/3}} \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \left(\frac{h}{k\theta}\right)^2 \right]. \quad (6)$$

From equations (5) and (6) we have, on neglecting terms of the order of $1/\theta$ compared to $1/T$ to be in conformity with our assumption $\theta/T \rightarrow \infty$ made in integrating (4),

$$\left(\frac{\delta U}{\delta T}\right)_V = 3Nk \frac{12\pi^4}{15} \left(\frac{T}{\theta}\right)^3 \left[1 + \frac{1}{32} \frac{\xi(3)}{\xi(4)} \left(\frac{h}{kTV^{1/3}}\right) \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \right] / \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) + \frac{1}{9(6\pi)} \frac{\xi(2)}{\xi(4)} \left(\frac{h}{TV^{1/3}}\right)^2 \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) / \left(\frac{1}{c_1^3} + \frac{2}{c_2^3}\right) \right]. \quad (7)$$

Thus we see that the constant volume specific heat depends upon the volume of the specimen, and though the correction due to this cause is ordinarily altogether negligible, yet for deep temperatures and when the substance is in the form of a fine powder (small value of V) the correction would be appreciable.

A detailed discussion including the effect of a more accurate enumeration of the normal modes on the magnetic properties will be given elsewhere.

Physics Department,
University of Delhi.
Delhi, 25-8-1940.

D. S. KOTHARI

¹ SCIENCE AND CULTURE, 6, 246, 1940.

² See Saha and Srivastava, *J. Treatise on Heat*, § 443.

Supplement.

Indian Science News Association Proceedings of The Fifth Annual Meeting

The fifth Annual General Meeting of the Indian Science News Association was held at the University College of Science, Calcutta, on the 27th August last at 6 P.M.

Dr. S. C. Law, President of the Association, was in the Chair and Dr. S. S. Bhatnagar was the guest-of-honour.

The proceedings of the last Annual General Meeting were read and confirmed.

On behalf of the secretaries Professor S. K. Mitra submitted the following report of the working of the Association and the audited statement of accounts for the year, 1st July, 1939 to 30th June, 1940.

REPORT.

The Council of the Indian Science News Association have pleasure in submitting this, the fifth annual report and the statement of accounts for the period July 1, 1939 to June 30, 1940.

MEMBERS

The Association has at present only one category of members, *viz.*, life-members and their total number in the list as corrected up to 30th June, 1940, was 88. We had to delete, with regret, names of 3 members as they had been in default in spite of repeated reminders. Eight new life-members joined us during the year.

SCIENCE AND CULTURE

Our journal continued to maintain the high standard in scientific journalism which it had attained in the few years of its existence. Well-known scientists and experts contributed authoritative and instructive articles in the last volume. Amongst these mention may be made of Dr R. A. Millikan, Sir M. Visvesvaraya, Dr John B. Grant, Lt.-Col. D. H. Gordon, Col. R. N. Chopra. In our editorials and in the various articles published in the section

"Science in Industry" we drew pointed attention of the public, to the necessity of approaching the economic and industrial problems of our country in the proper scientific way. You will remember that for sometime past we have been urging upon the Government the necessity of establishing a department for initiating researches into industrial problems and of mobilising the scientific talents of the country. It is gratifying to note that our campaign has borne some fruit and that under the stress of war the Government of India has formed a Board of Scientific and Industrial Research, whose director, Dr S. S. Bhatnagar is our guest-of-honour today. We are sure the Board will in near future attain the same status and importance and play the same role in the industrial regeneration of the country as the Department of Scientific and Industrial Research of Great Britain. We are glad to note in this connection that many of the members of our editorial board and of our editorial collaborators are serving on the various committees of this newly formed Board.

The total number of copies of SCIENCE AND CULTURE despatched in June, 1940, was 717 as compared with 692 in the same month in 1939. We had a steady increase in the number of subscribers during the period under review. The number on June 30, 1939 (including life-members) was 500 and that on the same date in 1940 was 572 showing an increase of 72.

We continued to send the journal free to a number of distinguished persons and scientific writers in India and abroad so that the views expressed by us might have wider publicity through them. We have already received appreciative letters from them, and may mention for instance the comments made by Sir John Marshall on our editorial on the Report of Sir Leonard Woolley on the work of the Archaeological Survey of India.

Foreign and Indian journals like the *New York Times*, *Armchair Science*, *Discovery*, *Statesman*, *Aryan Path*, *Indian Review*, *Modern Review*, etc., quoted from our articles and notes, and commented on our views on various subjects.

During the period under review we had some changes in the printing arrangement of the journal. You are aware that in June, 1935, when the Association was started, we entered into an agreement for a period of two years with the Indian Press Ltd., in regard to the printing and publishing of *SCIENCE AND CULTURE*. It was a part of the agreement that they would be responsible for publishing the journal every month under the editorial direction of the Association. After the period of agreement was over the Indian Press chose to continue as printers up to October 1939, when, we were reluctantly compelled to sever our relations with them as they wanted a substantial increase in their rates. We would like to record here our appreciation of the services rendered by the Indian Press Ltd., and would specially mention Mr H. K. Ghosh, the General Manager of the Press, for his coming to our assistance and undertaking the responsibility of publishing the journal in its earlier days. Arrangements for printing the journal was then made with the Commercial Gazette Press in November, 1939. We are sorry to report that for various reasons we were unable to continue the arrangement and, from the first number of the present volume, the printing is being done at the Sri Gouranga Press. We wish to record here our sense of appreciation of the helpful co-operation which this Press has extended to us by agreeing to a substantial reduction in their usual rates.

EXCHANGE JOURNALS

The total number of copies sent out every month in exchange and for review purposes was 63 on June 30, 1939. The number increased to 72 by December, 1939. After that date, however, the number dropped to 53 due to war conditions and to a revision of the list. Amongst the journals received in exchange we have 11 English, 15 American, 7 Indian and 1 Australian journals. We receive proceedings of 15 learned societies and 3 Calcutta newspapers on exchange. There are 20 scientific societies and public institutions in this country and abroad to which the journal was regularly sent on request.

Unfortunately, we have not yet been able to make the journals, received in exchange, available to our members and to the interested persons by displaying them in a reading room of the Association. We have however arranged to issue these journals on loan to the members from the office of *SCIENCE AND CULTURE* and an announcement to this effect was published in the journal on several occasions last year. A few of the journals are now kept on the table of the library of the physics department of Calcutta University where students have an opportunity of reading them.

GRANTS AND DONATION

We are glad to announce that the University of Calcutta, the Indian Association for the Cultivation of Science and the Bengal Chemical and Pharmaceutical Works renewed their annual grants. Dr S. C. Law and Sir Upendranath Brahmachari have made further substantial donations to encourage us in our work and Dr Bimala Churn Law, one of our new patrons, has made the handsome donation of Rs. 1,000. We express our sincerest thanks to them. The list of the grants and donations are as follows:—

University of Calcutta	...	...	Rs. 500/-
Bengal Chemical & Pharmaceutical Works, Ltd.	...	...	Rs. 500/-
Indian Association for the Cultivation of Science	...	...	Rs. 100/-
Dr. S. C. Law	...	...	Rs. 1,500/-
Sir Upendranath Brahmachari	...	...	Rs. 500/-
Dr. Bimala Churn Law	...	...	Rs. 1,000/-
Mr. Prahlad Chandra Roy	...	...	Rs. 200/-

To the authorities of Calcutta University we are further grateful for allowing us to use one of the rooms in the buildings of the University College of Science.

APPEAL

There is no need for us to dilate here upon the importance of the various subjects concerning national welfare which we have been discussing in our journal. We desire very much that the articles, the discussions, the news regarding the latest advances in science and their applications and the various other matters which appear in our journal should receive the widest possible publicity. You can render great help in regard to this if you take a little trouble to bring the journal to the notice of your acquaintances. You have probably received a leaflet containing an account of the principal contents of the last volume, together with a circular letter requesting you to recommend names of prospective subscribers. Your personal efforts in the matter, coupled with our own, will certainly bear fruit. In this connection we would mention the name of Mr S. Basu, Meteorologist at Delhi, who has secured for us a dozen subscribers for which the Association is grateful to him.

You will appreciate that we are not yet in a position to create a reserve fund out of the fees of the life-members and of the donations received. The financial help which we have been receiving for our good cause just enables us to meet the annual deficit. It should not be forgotten that this source of income is very limited and hinders us in preparing our budget in advance. We would appeal to our members and to the friends who have kindly come here today to extend their sympathy and to help us in raising more funds.

There are now signs that our countrymen have begun to realise the extreme importance of studying the effects of the impact of science on society. The contemporary world situation itself is a forceful reminder of the obligations of science to society and

of society to science. At such times a journal like SCIENCE AND CULTURE is of the greatest value in disseminating knowledge and inculcating the critical as well as the constructive scientific spirit among our fellow countrymen.

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1940.

RECEIPTS	Rs.	as.	p.	Rs.	as.	p.	PAYMENTS	Rs.	as.	p.	Rs.	as.	p.
To Opening Balances on 1-7-39 :							By Establishment ...				2,968	0	0
(a) At Bengal Central Bank, Ltd. in Current A/C as per Pass Book ...	715	7	11				„ Printing ...				5,080	13	6
(b) At Bengal Central Bank, Ltd. in Science & Culture S. B. A/C as per Pass Book ...	451	8	10				„ Paper ...				2,242	10	8
(c) Cash at Office ...	94	9	9				„ Postage & Receipt Stamp ...				674	15	0
				1,261	10	6	„ Conveyance & Travelling ...				282	1	0
„ Donation ...				8,200	0	0	„ Telephone ...				215	7	6
„ Grant ...				1,100	0	0	„ Miscellaneous ...				107	18	0
„ Life-Membership Fee ...				1,009	0	0	„ Audit Fee ...				30	0	0
„ Subscription ...				2,692	9	9	„ Bank Charges ...				26	6	0
„ Advertisement ...				321	12	9	„ Furniture ...				93	12	0
„ Reprint ...				2,575	12	9	„ Binding Charges ...				7	12	0
„ Bank Interest ...				23	11	11	„ Stationery ...				88	0	8
„ Miscellaneous ...				259	12	10	„ Closing Balance on 30-6-40 :						
							(a) At Bengal Central Bank Ltd. in Current A/C as per Pass-Book ...	845	0	9			
							(b) At Bengal Central Bank Ltd. in Science & Culture S. B. A/C. as per Pass-Book ...	818	7	6			
							(c) Cash at Office ...	18	4	0			
											1,176	12	3
				12,344	6	9					12,344	6	9

I have audited the above Receipts and Payments Account of INDIAN SCIENCE NEWS ASSOCIATION for the year ended 30th June, 1940, with the books and vouchers and have obtained all the information and explanations I have required. Subject to my separate report (printed below) of even date I certify that the said account is correctly stated and is in accordance with the books of accounts of the Association.

10, Old Post Office Street,
Calcutta, the 6th August, 1940.

Sd/- S. K. MITRA,
9-8-40.

Secretary.

Sd/- P. C. MITTER,
9-8-40.

Treasurer.

Sd/- A. K. GHOSH,
Government Diplomaed Accountant
Registered Accountant.

Auditor's Note

"With reference to the qualifying clause in the Receipts and Payments Account of the Indian Science News Association for the year ended 30th June, 1940, I am to observe as under :—

Life-Membership Fee : It is desirable that the amounts received on account of life-membership fee be ear-marked and specially invested.

General : Of Rs. 2,242-10-3 disbursed under Paper Account, I am informed by the Hony. Secretary that Paper worth Rs. 660-12-0 was in stock as on 30th June last. The outstanding bills payable to Creditors as also the amounts receivable in respect of Advertisement, Subscription and Life-Membership Fee should be properly ascer-

tained at the end of the financial year. An inventory of Furniture purchased up to 30-6-40 should be made at an early date."

In presenting the statement of accounts together with the auditor's note, Professor Mitra observed that they had cleared last year dues to the Indian Press of about Rs. 2,000/- on account of printing costs outstanding during the past two years. He assured the members that from next year accounts will be kept up showing the amounts receivable and payable at the end of the year and also an inventory of furniture, which have been purchased very recently. Regarding the creation of a reserve fund, he regretted that the present financial position did

not allow such a fund but as soon as the conditions improve the Council will be too glad to provide for a reserve fund.

OFFICE-BEARERS

After the adoption of the annual report and the statement of accounts, the following office-bearers of the Association and members of the Council for the year 1940-41 were elected :—

President : Dr S. C. Law ; *Vice-Presidents* : Sir Upendranath Brahmachari, Dr Baini Prashad, Prof. M. N. Saha, Dr B. C. Law, Dr S. P. Mookerjee and Prof. P. N. Ghosh ; *Treasurer* : Prof. P. C. Mitter ; *Secretaries* : Prof. S. K. Mitra and Prof. B. C. Guha ; *Members* : Prof. S. P. Agharkar, Dr S. S. Bhatnagar, Mr. H. P. Bhaumik, Prof. D. M. Bose, Mr Rajsekhar Bose, Lt.-Col. A. C. Chatterjee, Col. R. N. Chopra, Mr A. T. Ganguly, Prof. J. C. Ghosh, Dr M. Qudrati-Khuda, Dr D. S. Kothari, Mr. B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Prof. J. N. Mukherjee, Prof. B. B. Ray, Mr N. C. Ray, Prof. P. Ray and Prof. N. R. Sen.

The editorial board for the journal, *SCIENCE AND CULTURE* was constituted with Prof. M. N. Saha, Prof. J. C. Ghosh, Dr A. C. Ukil and the two Secretaries of the Association, Professors S. K. Mitra and B. C. Guha.

Dr S. C. Law next welcomed the guests. His speech is published on p. 197 of this issue. Dr S. S. Bhatnagar next addressed the gathering. His address appears on p. 194 of this issue.

Mr A. L. Ojha in proposing a vote of thanks to Dr S. S. Bhatnagar observed that the recent establishment of the B. S. I. R. with Dr Bhatnagar as the director augured a bright future for the industrial enterprises in the country. So long there was very little co-operation between science and industry in this country and the capitalists and the industrialists of the country had been condemned for this but a share of this blame should be borne by the scientists too, who are only now interesting themselves in indus-

trial problems. He was certain that finance would not be lacking. The capitalists, who, as Dr Bhatnagar hinted, speculated so much in the stock exchanges, require to be convinced of the potentialities of the various industrial ventures. He hoped that the basic researches for rehabilitation of some of the present industries and for starting new ones would be carried on under the aegis of the B. S. I. R., and science would be closely associated with the industries for ushering in a new economic era in the country.

Dr John B. Grant in proposing a vote of thanks to Dr S. C. Law said that on his coming over here from China he felt for sometime the absence of an academic atmosphere in Calcutta. But his connection with the Indian Science News Association has partly made up that deficiency. Its monthly journal, *SCIENCE AND CULTURE*, has been doing a good service in creating the much-needed scientific vision. People here are slow to realise that science in one form or other has entered into every element of our social structure. It can no longer be considered as separate and distinct from other forms of human activity. *SCIENCE AND CULTURE* is likely to be a standard scientific journal like the *Nature* of England and the *Science* of U. S. A. It is in the fitness of things that Dr Law has contributed a great deal to the success of the Association. He has heard several times about Dr S. C. Law's varied interests and munificence towards similar worthy causes. He combines wisdom with wealth and a broad outlook with his philanthropy.

Mr G. L. Mehta associating himself with Mr Ojha and Dr Grant complimented the scientists, who have organised the Indian Science News Association, for having put energy into Dr Law, whom we find here today. Due to shyness he generally keeps away from public platforms. Dr Law's interests in matters, industrial, economic and scientific are really very encouraging. He has been doubly blessed by the goddess of wealth and the goddess of learning. The Law family of Calcutta stands out as a rare example in this direction.

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Need for a Planned Development of Broadcasting in India

WE are publishing elsewhere in this issue a review of the *Report on the Progress of Broadcasting in India* published by the Government of India. A perusal of the report leaves one with the impression that at a time when broadcasting had been making enormous strides in other countries the government of this country had been pursuing a half-hearted policy in regard to its development. The funds allocated by the Government of India for broadcasting development have till now been strictly limited and it is doubtful if, under the circumstances in which the All India Radio had to work, a quicker and greater development of broadcasting than what has been achieved in the last few years, could have been expected. The Controller of Broadcasting remarks that the sum of Rs. 40 lakhs available for development of broadcasting over an area 30 times that of the British Isles and a population of 400 million is less than the money available for providing only a television service to the city of London. The result of this policy, or rather the lack of any policy has been that India still remains the lowest in the scale of broadcasting development. The latest figures for the number of listeners in this country is 3·3 per 10,000 of population and may be compared to (about) 300 per same number for England. The Government of this country has evidently failed to realise the immense importance of broadcasting and is oblivious of the fact that it is a powerful tool in the hands of any Government, which knows how to use it, in

shaping the character and the political views of a nation. Broadcasting is no longer a luxury ; it is a necessity in the cultural life of a nation. ...

The development of radio and its fuller utilisation on a wider and planned basis has special significance for India. The root cause of the backwardness of this country in almost every sphere of life is ignorance and poverty, and, these two act and react on each other. There is the perpetual vicious circle of ignorance leading to poverty and poverty standing in the way of dispelling ignorance. There is, however, at least one country in the world, the U. S. S. R., whose problems are not very different from those of India but which has been able, by strenuous efforts, to break this vicious chain. And, one of the most powerful tools employed by this country for the purpose has been the extensive use of radio amongst the rural population. The first step towards dispelling ignorance and superstition amongst the masses, handed down from generation to generation, and inculcating progressive ideas in their minds is to devise a scheme by which they can be talked to, taught and advised with sympathy and understanding—not once or twice—but continuously day after day and year after year. Any ordinary scheme like that of covering the rural areas with a network of schools for adult education is obviously impossible on account of its tremendously expensive nature. The only scheme which is practicable and which will not be of prohibitive cost is one of

teaching the masses through radio. If the Government launches upon a well-planned scheme for this purpose, they would not be doing a thing which has not been tried elsewhere. As hinted above, it has been used with so great a success by the U. S. S. R. that their Government is determined to continue making its fullest use till it strikes at the very root of ignorance and poverty, the greatest curse of the peasant class who forms the backbone of a nation. We are glad to note that the A. I. R. have made attempts in this direction by installing what may be called community receivers. Such sporadic attempts are, however, of little value and we think that the time has come for the Government to launch a properly planned scheme for installation of community receivers throughout the whole country.

SOME SUGGESTIONS

We may perhaps be permitted to make a few definite suggestions to the Government in regard to broadcasting development as we have spent some thought on the subject. In making the suggestions we would be drawing freely on the recommendations made by the Communication Services Sub-Committee of the National Planning Committee.

1. The Government should adopt a definite policy in regard to the fullest utilisation of the broadcasting service for rural uplift work as is being done by the U. S. S. R. which had been faced with problems similar to those in this country.
2. A representative body called the Central Broadcasting Advisory Council should be set up, the function of which would be to advise the Government in regard to the policy of expansion of the service in all its branches. The Council should be a representative public body drawn mainly from men and women outside the Government and consisting of scientists, educationists and outstanding figures in public life. It will be incumbent on the Government to pay due regard to the advice of this body in formulating their policy. Our object in proposing this Council is that, because of its immense scope in nation-building work, the responsibility of formulating the policy of development ought to be in the hands of an equally responsible public body commanding the country's confidence.
3. Since the fullest utilisation of the service depends upon the nature of the programme, it is suggested that there should be a Central

Programme Board which will lay down from time to time the general policy of the national programmes. There should also be Provincial Boards which would indicate the subjects which are of immediate benefit to the rural and urban population of the provinces or regions concerned.

4. The service should be expanded to give first grade reception, if not over the whole of India, at least over its populous parts.
5. Broadcasting service is not of much use without a wide distribution of receivers. At present the cost of even the lowest priced receiver is beyond the means of the middle class people, who should form the bulk of listeners. It is therefore of utmost importance that cheap receivers should be made available and a drive should be made for increasing their number from 3·3 per 10,000 to 3 per 1,000 in course of next ten years. For this purpose it will be necessary to investigate on the manufacture and distribution of cheap people's sets.
6. There should be wide installation of community receivers on a planned basis. Each Provincial Government should appoint an agency whose duty would be to do propaganda work in this connection.
7. The Research Department should be strengthened for carrying on efficiently researches of a technical nature which are of immediate importance to the engineering side of broadcasting.
8. A Radio Research Board on lines similar to those in England should be established for carrying on investigation on problems of a fundamental nature, specially those peculiar to the country, in collaboration with universities and other research institutions where equipments for such work are available.*

The above plan of development may be made on a 10-year basis and an adequate sum should be set apart for the purpose. Considering that only Rs. 40 lakhs have been spent for the present development, a sum of 4 crores of rupees, for the purpose, spread over ten years is not certainly extravagant. We are strongly of opinion that the allocation of funds for broadcasting development should not be made on a rigid profit and lost basis.

* The necessity of establishing a Radio Research Board has already been discussed in this journal and the reader is referred to Vol. 2, pages 460-72, 1936-37.

Progress of Broadcasting in India

FOR the first time since 1932, when the Government of India definitely decided to continue the broadcasting service under State management, the Controller of Broadcasting has published a Report* on the working of All India Radio, extending to March 31, 1939. Though presented in the form of an annual report, the present volume includes a historical survey of the development of broadcasting in this country.

HISTORY OF THE DEVELOPMENT

The history of organised broadcasting in India dates back to 1927 when the Indian Broadcasting Company, started as a purely commercial concern, opened their transmitting stations at Calcutta and Bombay. The next five years saw very little progress. In 1930 the company went into liquidation and the Government of India was urged to take up the work. The Government however could not come to any decision until 1932, when they finally made up their mind to continue the service under State management. Like many other activities of the Government of India in the scientific and technical spheres, the progress, even after 1932, was extremely slow. Some advancement however has been achieved since 1935 when the Government decided to allot a sum of Rs. 20 lakhs for the development of broadcasting and a separate office of Controller of Broadcasting was created under the Department of Industries and Labour of the Government of India. The first controller to be appointed was Mr Lionel Fielden, recruited from the British Broadcasting Corporation. In the next year a further grant of Rs. 20 lakhs (making a total of Rs. 40 lakhs) was made for the same purpose and the services of Mr H. L. Kirke of the B. B. C. was requisitioned for working out a scheme of expansion of broadcasting in India. The present volume gives a resumé of the development scheme put forward by Mr Kirke, and the later modifications suggested by the Chief Engineer, Mr Goyder. This is followed by an account of the activities of the department, such

as programme composition, maintenance of public relations, general administration and technical and research work.

In drawing up the scheme for the expenditure of Rs. 40 lakhs, Mr Kirke rightly observed that the service which can be given to India for this paltry sum must be very poor indeed as compared with that given in western countries. As an instance, he mentions that in Europe, which may be compared with India from the point of view of size and coverage, there are over 100 high and medium power stations representing a total cost of nearly 10 crores of rupees.

Mr Kirke recommended the establishment of seven medium wave stations (in addition to those existing at Delhi, Calcutta and Bombay) and one short wave station at Delhi for the transmission of news from a central point. He also proposed that one medium wave station of 100 kW power, five stations of 5 kW power and two stations of 2 kW power should be established in various centres. It was estimated that the scheme would provide a service area giving a signal strength of 10 milli-volts per metre to 14 million people and a signal strength of 3 milli-volts per metre to about 35 million people, though, in the light of later experience, it has been found that Mr Kirke's estimates were rather too optimistic. His report also stressed the necessity of setting up a research department to undertake such work as field strength measurements, transmission tests, collection of information regarding atmospheric disturbances and the development of radio links. Mr Kirke also suggested that a Chief Engineer should be appointed without delay to supervise the technical and research departments. The general policy underlying the recommendations was "based on a compromise between providing a service to urban areas from which licence revenues may be anticipated, and providing such service to rural areas as may be offset in cost by the revenue obtained from the urban areas". This somewhat mercenary policy of regarding the State Broadcasting Service as more or less a commercial undertaking and not as a social service, was attempted to be justified on the ground that if broadcasting is to develop in this land, "the service must have a

* Report on the Progress of Broadcasting in India. Published by the Manager of Publications, Government of India, Delhi, 1940. Price Rs. 3 or 5 shillings.

life of its own and strength to survive budgetary fluctuations".

Following the recommendations of Mr Kirke, Mr C. W. Goyder, formerly of the British Broadcasting Corporation, was appointed Chief Engineer in 1936. Mr Goyder did not fully agree to the proposals of Mr Kirke in concentrating upon medium wave transmitters which would make it possible to cover only a small percentage of the total area of the country, with the funds allotted by the Government. He put forward an alternative scheme of providing a basic short wave service even though of a somewhat inferior grade, to the whole of India, and then supplementing the same with first grade medium wave service at important centres which may be gradually extended as, and when, further funds become available. It is remarkable that Mr Kirke's full report never saw the light of the day nor are the public aware if the Government of India considered it necessary and proper to consult Mr Kirke before deciding upon the alternative scheme suggested by Mr Goyder. On too many occasions specialists are readily imported from Great Britain to render advice in connection with particular problems or development schemes and the reports submitted by these experts are pigeon-holed in the archives of the Government. We do not know if the Government realises that the public funds spent in importing such specialists serve scarcely any useful purpose if their reports are only of academic value and the Government does not find it possible to make much use of them.

As a result of discussions between the Government of India and Local Governments it was decided to modify the scheme of Mr Kirke and start, in addition to the already existing medium wave stations at Delhi, Bombay, Calcutta and Peshawar, four 10 kW short wave transmitters at Delhi, Bombay, Calcutta and Madras which could be regarded as almost covering the whole of India and providing a service (second grade) which would not be unsatisfactory to the average listener. The modified scheme also made provision for 5 kW medium wave stations at Lahore, Lucknow, Dacca and Trichinopoly and a 5 kW short wave station at Delhi. The new transmitters were ordered in January 1937 and have since come into operation.

At the time of formation of the Indian State Broadcasting Service the engineering and technical control was vested in the Posts and Telegraphs Department but, following the recommendations of the Kirke

report, these activities were re-transferred to All India Radio to avoid divided control between administration and engineering. The activities of the engineering department have been concerned with the planning, installation, maintenance and operation of broadcasting centres.

RESEARCH DEPARTMENT

Pursuant to the report of Mr. Kirke a research section was added to All India Radio in 1937. The section consists of a research engineer and a technical staff, and is required to collaborate with the engineering department. It is fit and proper that the All India Radio should maintain such a department. Research is the fountain head of progress and without it all development comes quickly to a standstill. Unfortunately, the attitude towards research in this country, even of men who ought to know better, is sometimes distressing. There are men who style themselves as "practical men" or "men of action", who think that research is only an academic affair and has little bearing on the successful maintenance of a technical service. They are of opinion that once the requisite machineries have been installed and the thing has been set going one need not bother oneself about research. If the machines wear out they are simply to be replaced by importing fresh ones; if any improvement is desired that can be easily achieved by bringing from abroad newer types of machines of the latest models. These so-called men of action are all clever people and it is difficult to believe that they do not know the far-reaching importance of research; in their own countries they must have seen ample evidence of it. Yet, whenever the question of carrying on research in India is raised, they develop this practical frame of mind and maintain that if any research work is to be done let that be done at Home; here in India we need only utilise the fruits of these researches. One wonders how such clever people could be ignorant of the fact that there are problems, the solutions of which can only be obtained by intensive research in the country of their origin. This is particularly true in the case of problems connected with broadcasting development and we may quote here in this connection the opinion expressed by some very famous scientific men of England.* Says Dr E. V. Appleton: "India has its own radio problems the solutions of which depend upon workers in India. This cannot follow from work carried out in other

* See SCIENCE AND CULTURE, 1, 755, 1936-37.

parts of the world". Sir Frank E. Smith says, "The problems associated with the field strength of received signals at different times of the days and at different seasons of the year with different wavelengths and with different aeriels are examples of those of a local nature which can only be solved by work in the country desiring information". Sir Richard Gregory (Editor of *Nature*, since retired) says, "It does not seem to be realised by people in power in India that every country has its own problems in regard to satisfactory transmission and reception of broadcasting and that this can only be solved by systematic study of the conditions in different parts of the country". We therefore repeat that the All India Radio moved in the right direction when it decided to establish a research department, be that only as an appendage of the engineering section.

A perusal of the *Report* shows that the research department has undertaken the study of subjects like field strength measurement, atmospheric, design of village receivers, studio design and the ionosphere. Considering the men and money at the disposal of All India Radio it is indeed an ambitious programme. We doubt if the research department of the B. B. C. at Nightingale Square with its large resources would dare undertake such a programme which is a combination of its own with that of the Radio Research Board. A problem like acoustic properties of a studio is a technical problem directly concerned with the operation of a broadcasting centre and, as such, naturally falls within the scope of the research department. But it may be questioned if the research department can do justice to subjects like atmospheric or the study of the ionosphere which fall within the category of *geophysics* and which, like all other subjects in this category—*meteorology* and *seismology* for instance—require long continued observations for their elucidation and for abstracting any data regarding their nature and behaviour which may be of practical use. We are sure the department realises that it is fallacious to draw any general conclusion from a record of observations made at a particular place for a few days in the year. If it is thought that the necessary knowledge about the origin and distribution of the Indian atmospheric (for instance) have been gained from the set of curves given on page 100, the position would be the same if the India Meteorological Department were to claim that they know all that is necessary to know about Indian climatic conditions as they have records of, say, the rainfall, the temperature and the mean

wind velocity at Delhi for some selected months of a particular year. We venture to remark that it is only from a close analysis of records kept over long periods by observational stations properly distributed over different parts of the country according to their climatic peculiarities that one can hope to obtain any reliable information which may be of practical value for subjects like ionospheric condition, atmospheric or the angle of incidence of downcoming waves from outside stations. Here we anticipate a retort from the All India Radio. We hear them saying, "We know all these; we know the importance of synoptic studies of phenomena connected with radio wave propagation; but you cannot expect us to carry out a programme of observations on a grand scale as suggested by you with the men and money at our disposal." We thoroughly agree with this. But, under ordinary circumstances, what does a man do when he is short of resources? He seeks co-operation. We therefore ask, "Has the All India Radio at any time sought the co-operation of or has suggested establishment of an organisation through which such co-operation could be brought about between the research department of All India Radio on the one hand and the scientific institutions of the country on the other, at which many of the problems mentioned above were being investigated long before the All India Radio came into existence?" We find that under the stress of the war the Government of India have thought fit to bring into existence a Board of Scientific and Industrial Research the aim of which is to mobilise the scientific talents and the research institutions of the country for investigations on subjects of immediate importance to the war. We wonder why the All India Radio has not moved in similar lines and sponsored the formation of a Radio Research Board which would act as a sort of clearing house of urgent problems by distributing them to the universities and other institutions which have been carrying on investigations on similar problems. Such a co-operation will be extremely helpful, not only for the present but also for future development of radio in this country.

Apropos the publication of the results of investigations carried out by the research department we would like to make a few observations. We see, from time to time, announcements regarding the researches carried out in the popular journals or in reports submitted to the Government. But we look in vain for any technical account of the same in scientific journals. Such descriptions of the researches of the

department on village receivers, on atmospherics, on pulse records would be extremely useful and important. The B. B. C. for instance, adopts a commendable practice in this connection. They publish technical accounts of the investigations on which they base the designing of their new undertakings. We read with considerable interest in a recent issue of the *Journal of the I. E. E.* a paper embodying results of investigations carried out by them on the design of suitable aerials and feeder systems for Empire broadcasting. We would have certainly liked such a technical paper from the research department of A. I. R. on the investigations which, we believe, they must have made before they decided upon the type of aerials and their locations above the ground, the wavelengths to be used and the sites for the erection of transmitters, for the very novel type of service they introduced, namely, serving up to a distance of 800 km. around the transmitter with indirect ray using wave-lengths in the 60 and 90 km. bands. We must confess that the sketchy account of the researches given in the *Report* (pp. 92-95) is not only disappointing but also confusing. It can neither be understood by the lay public, nor, can in the least satisfy the technical expert.

TECHNICAL TRAINING

We note that there is arrangement for training of two members at a time in the programme side, at the B. B. C. This is a very desirable arrangement as the highly developed B. B. C. organisation affords unique opportunity to the A. I. R. staff for learning every aspect of broadcasting. We only wonder why this arrangement is confined only to the programme section. We believe there is equal, if

not better, scope for training for the young technicians of the A. I. R. in the engineering and research sections of the B. B. C. If the scheme for training could be framed and worked successfully for the administrative side, there is no reason why it should not be so for the engineering and research sections. We cannot help noting in this connection that in the matter of pay and prospects also men in the programme side are given preference to men of similar, or better qualifications, in the engineering and research sections. It is difficult, for instance, to appreciate the difference between the scales of pay of a programme assistant and a technical assistant.

CONCLUSION

In concluding our review we would mention that the *Report* issued by the Controller is a most readable one and contains a variety of information which is otherwise not available. There are tables, charts, graphs and diagrams depicting the results of observations and enquiries. We read with particular interest the comments made by the author of the *Report* on the language difficulties in this country and also his enumeration of the various viewpoints taken in this connection, by men of different schools of thought (p. 67). His remarks regarding classical and light music and the possibility of orchestration and of introducing harmony in Indian music are worth considering (p. 23). These views, coming as they are from a foreigner who had an opportunity of looking at the questions from a dispassionate viewpoint, are particularly valuable as they show what an outsider thinks of the social and cultural problems with which we are faced in India.

Role of Mathematics in Economic Statistics*

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ETYMOLOGICALLY as well as historically, there is an intimate relation between "State" and "Statistics". It is no wonder therefore that Economic Statistics forms a large part of the subject. In early days, statistics meant economic statistics alone,—not only in the days of the *Artha-Sastra* by Kautilya, nor even in the days of the *Ain-i-Akbari* by Abul-Fazl, but even in the days of *Political Arithmetick* by Sir William Petty. Even at the present time the importance of economic statistics cannot be overrated. With the gradual development in other branches of the subject, economic statistics has also continued to advance. Formerly it meant simply averages, diagrammatic presentation of data already collected, but now it has attained greater practical importance as the results of sample economic surveys are being applied to large "populations" in accordance with the theory of probability.

RANDOM SAMPLE SURVEY

This is of great practical importance for two reasons, *viz.*, on grounds of economy in expenditure and in time. In these days of rapid changes, a complete enumeration may involve so much delay that by the time the inquiry has been completed with meticulous care, the conditions investigated may have changed so greatly that the results obtained are of no practical use whatsoever. The modern mathematical theory of sampling has been put on a satisfactory footing only a generation ago, with the discovery of the X^2 -test by Karl Pearson in 1900. But the application of the sampling theory to economic data is beset with many difficulties. The "population" is generally extremely unstable and the variance does not remain substantially the same over time. The purely random errors are not sufficiently small to provide a suitable criterion for

judging the character of systematic variations. More light is needed from mathematicians in order that sampling may be resorted to with confidence in economics.

INDEX NUMBER

Let us consider for instance the problem of index numbers of prices, which is of vital importance in economics for measuring the value of money. So far as the purely economic aspect is concerned, that has been put on a satisfactory basis by Keynes nearly ten years ago. The different uses of money—for buying goods and services for consumption, for settling debts, for carrying on speculative transactions etc., have been gone into in detail and appropriate series of index numbers have been evolved. But much remains to be done in the mathematical aspect of the subject.

BASE PERIOD

The first problem is that of the base period, with reference to which variations in prices are to be studied. It has been said by somebody,—not an economist,—that twelve economists have thirteen opinions. But so far as the question of the base period is concerned, there is a substantial measure of agreement among economists. Internally, price and cost should be at a parity in order that *entrepreneurs* may continue to produce at a steady rate, there being no stimulus of windfall profit to increase their production, nor any brake of windfall loss to curtail their output. Similarly the conditions of external equilibrium have been formulated. But there still remains the serious and difficult problem of interpreting such conditions of external and internal equilibrium in terms of available statistics not only in India but even in advanced countries.

* Adapted from an address delivered before the Calcutta Mathematical Society.

WEIGHTING

Another difficulty arises out of the fact that all prices are not equally important. Appropriate weights must therefore be applied before averaging. But how to do so? The relative importance of the goods and services in the base period might have been different from that in the period under consideration. What set of weights is then to be chosen? Here also the economics has been worked out by Cournot as early as 1838. At any given time, the relative quantities must be functions of prices. If butter is very dear, margarine will have to be consumed in place of butter. This is quite evident. Both from the point of view of demand and from the point of view of supply, substantial advance has been made in the principle of equivalence or substitution in economic theory. But even with the help of n -dimensional space, the system of indifference curves representing bundles of goods and services yielding the same utility has not been satisfactorily studied. But until that is done, "weights" cannot be expressed as functions of prices and there must remain the present conflict between weights in the base period and weights in the period under consideration.

AVERAGING

There remains also the problem of averaging. It must be remembered that the price data are extremely intractable and that for two reasons,— firstly because they do not constitute a normal "population" and secondly because they are mutually correlated. Some attempts have been made by mathematicians either to "normalise" data which are not normal, or to make some allowance for the absence of "normalcy". But no successful efforts have as yet been made to develop the theory of distribution of correlated items. If mathematicians continue to interest themselves only in abstractions, they have no right to blame economic statisticians. For the latter are only too conscious of imperfections in their methods which they try to improve as best as they may.

TIME SERIES AND HETEROGENEITY

In economics most of the data are in the form of time series and are therefore mutually correlated, thus violating, as stated above, the basic assumption of independence required for the application of

the probability theory on which all modern statistical tools are founded. The "population" again does not remain stable throughout. If we have a series of value figures, say for the foreign trade of a country, we cannot assume that the purchasing power of money has remained the same throughout. The number of inhabitants of a country may have gone up in the meantime so that the aggregate consumption has also increased but the consumption per head may have declined. This is sound common sense. But this common sense is conspicuously absent when it is argued that because there has been an increase in the number of schools, in the number of school-going children, and in the amount spent on elementary education, there has necessarily been educational advancement, for it is obvious that if the number of children of school-going age has increased to a larger extent than the number of children actually going to school, there has in fact been a set-back to elementary education in the country concerned.

POLICY OF DIVIDE AND RULE

The close connection between "State" and "Statistics" has already been referred to. Like an astute statesman, an economic statistician divides and rules. Thus in the case of value data, he divides them by the appropriate index number of prices, and with these ratios or what he calls "deflated values", he lords it over undismayed by heterogeneity. Similarly he reduces consumption to a *per capita* basis by simple division so as to get a comparable set of figures. In the case of the last instance he divides the number of children actually going to the school by number of children of school-going age, and works with the ratios thus obtained.

STATIC AND DYNAMIC ECONOMICS

But a policy of divide and rule is successful only in the short run. We often have to pay very dearly for political short-cuts. Similarly in economic statistics, the process of simple division fails to reduce the data to homogeneity, if they cover a fairly long period. For there is an inherent assumption about other things remaining the same, which is not always valid in practice. Economic statisticians have by now realized the futility of classical or statistical economics, in which the forces of demand and supply and all other economic forces have full play, resulting into a condition of substantial equi-

brium, a small departure from which under the stress of a limited number of disturbing factor is the only subject matter of study. They have now come to know the importance of dynamic economics, that is to say, conditions actually ruling in a stage of disequilibrium intervening between one position of equilibrium and another. Thus changes or fluctuations have now become of vital importance in economics.

IMPORTANCE OF SERIAL STATISTICS

This is also desirable from the strictly mathematical point of view. For, as stated above, since the theory of distribution for mutually correlated items has not been fully worked out, it is clearly desirable to get rid of the interconnections as far as possible so as to be able to treat the residuals as random samples. For it must be remembered that this difficulty confronts not only economic statistics but many other types of serial statistics handled by sociologists, biologists, doctors, public health workers etc. The technique of analysis followed by economic statisticians may therefore prove to be of some use to a large body of statisticians, although the account given here must necessarily be very brief.

ECONOMIC CYCLES

The various changes in a time series have been analysed into four components: (a) secular trend; (b) cyclical movements; (c) periodic including seasonal factors; (d) irregular fluctuations. At the first sight, it may seem rather incongruous that cyclical movements and periodic factors have been separately classed. The fact is that economic cycles have neither their period nor their amplitude entirely the same throughout. On the other hand, such movements can scarcely be called random in view of the fact that the cycle at any time is influenced by the state of business during the preceding few months and does in its own turn affect the state of business during the succeeding few months. Whether we accept or not the "self-generative" theory enunciated by W. C. Mitchell, the doyen among cycle investigators, there is no doubt whatsoever that there are a series of ups and downs in most economic activity although such pulsations do not proceed with the regularity of a pendulum.

SEASONAL FACTORS

Periodic factors on the other hand repeat themselves with substantial similarity at regular intervals. Probably the type of periodic movement which has engaged the greatest attention is seasonal variation. Here the pattern is repeated within an interval of one year in each case. The chief reason is the earth's annual motion round the sun, bringing about variation in temperature, rainfall, insolation etc., which affect not only industries such as agriculture and building construction, but also industries catering to the manifold consumption needs of the modern society and the accompanying currency and exchange problems. In such cases the climatic factors are less pronounced, but their place is taken up by conventional seasonal factors such as religious festivals, e.g., the Pujah, Id or Christmas and business practices such as periodical closing of books and preparation of balance sheets. As summed up by Simon Kuznets in his monumental work on *Seasonal Variations in Industry and Trade* (p. 10), "Social life, like individual life, runs in grooves set by habits and customs, many of which spell recurrent modifications in the rate of economic activity."

SECULAR TREND

Mitchell in his scholarly treatise on *Business Cycles* sums up the features of the secular trend in the following words: "Lines of secular trend show the effects of causes which, though subject to change at any moment, have influenced an economic process in some regular or regularly acting way through periods of time long in comparison with business cycles." The lack of precision is apparent but unfortunately the definition cannot be improved upon. Two distinct methods of approach have been developed. One is based on what is called the law of growth. For instance, in the *Journal of the American Statistical Association* for 1922, Mr R. B. Prescott argues that every economic process has an initial period of experimentation, a subsequent period of growth into social fabric, a third stage during which this rate of growth is successively accelerated, becomes stationary and retarded, and a final stage in which there is no further growth. He therefore seeks to represent trends by Gompertz or Logistic Curves. Apart from the fact that this "law" is largely speculative, it cannot be applied to many series, for which however there seem to be

trends, *e.g.*, index number of prices. Another method of approach, which is usually resorted to, hits on an empirical law from a study of the data themselves, the technique is bewildering in its diversity. To quote from *Business Cycles* once again: "In the same piece of work, an investigator may fit a straight line to one series, a parabola to a second, compute three-year moving medians of a third and seven-year moving arithmetic means of a fourth, run a freehand curve through a fifth, use ratios to some other series for a sixth and devise some novel method for a seventh. He may even use two or three unlike methods of determining the trend in different sections of the same series!" Even if we make allowance for the fact that the business cycle investigators are concerned not with studying secular trends but with eliminating them as to get at the required cyclic fluctuations,—even then we must agree that there is enough scope for improvement in methods for determining not only secular trends but also seasonal, cyclic and irregular factors.

LEAST SQUARE FITTING

To give only one instance, in least square fitting, we assume that whatever error there is to be found in the ordinates, the abscissae is absolutely correct. In the case of the demand curve or of the supply curve, the error is associated both with quantity and with price. Economic statisticians

have fitted straight lines such that the sum of the squares, not of the y -deviations but of the perpendicular distances, is the least possible. But mathematicians have not yet given us any indication with regard to the standard error of the gradient of such lines. For higher degree curves, the method has not been worked out at all, probably because there may be more than one normal to such curves from an external point.

CONCLUSION

The above account incomplete and discursive as it is, nevertheless points to the fascinations as well as to the risks in the study of economic statistics. Here is a field which calls for acute mathematical sense, for it is mathematicians who can replace the present subjective methods by accurate objective processes. The practical importance of such a study cannot be over-emphasized. To give only one instance, if we can form accurate notions about the behaviour of time series, we should be able to forecast the general trend of business and avoid maladjustments in economic life now causing untold human misery. How unsatisfactory our present state of knowledge on the subject is may be inferred from this one fact that not even one economic statistician could give us any timely warning about the Great Depression of 1929. It is time that our technique for studying economic statistics should be improved.

Recent Technical Development in Wireless and Broadcasting in Great Britain

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THE author of this article was awarded by the University of Calcutta a Ghose Travelling Fellowship in Science (1938-39) for studying the recent developments in the technique, research and methods of instruction in wireless in general and in broadcasting in particular. The choice of these studies was made mainly on the following considerations: It was being felt for sometime that more stress could with profit be given to the vocational aspect of the post-graduate teaching in some of the science subjects of this University, particularly those which have wide practical applications. The subject of wireless is pre-eminently such a branch of physics. It has on the one hand intensive application in the practice of the art of radio communication and on the other has close association with the teaching of electric and magnetic phenomena in physics. It was therefore further felt that if the teaching of this subject—courses of the study of which already exist in the post-graduate physics classes—could be reorganised after the methods followed in the European countries, the students pursuing the course would be better fitted to take up responsible posts in the industries or in the communication services which are rapidly developing.

The author visited England in the year 1938 and spent about a year in touring round various centres of wireless research and teaching, such as Marconi's Wireless Telegraph Co., Ltd., Standard Telephones and Cables, Ltd., British Broadcasting Corporation, British Post Office, National Physical Laboratory, etc. Brief descriptions of the places and institutions visited are given below.

THE MARCONI SCHOOL OF WIRELESS COMMUNICATION

The first institution visited was the Marconi School of Wireless Communication at Chelmsford, England. The Marconis are the biggest manu-

facturers of wireless equipments in Europe and they maintain this school for imparting an all-round engineering knowledge in all branches of wireless communication to advanced students. The maintenance of such a school under the direct supervision of the pioneer manufacturers has the immediate advantage that the students can handle all types of commercial equipments. Such facilities are not available in any university college because of prohibitive expenses both for initial outlay and also for maintenance.

The School was originally intended for training university graduates joining the Marconi Company as wireless engineers. Gradually it became also a training centre for foreign engineers who were employed by the customers of the Marconi Company. At present it has developed itself into a regular institution whose facilities are also available to students who may not in any way be associated with the Company or its customers.

The School has a number of laboratories for general experimental work, a standard laboratory for specialized and precision work and a fairly well-equipped workshop. In addition, there are a number of field "huts", each of which is intended for a particular type of work; for example, one hut is reserved for work on broadcasting transmitters, one for general experimental transmitters for short and long waves, one for telephone terminal equipment, one for television and one for aerial measurements. There is also provision for some field work, specially in connection with feeders and their matching.

The course of instructions imparted in the School is broadly divided into two sections. The first is the general course and the second the advanced course. The School also undertakes to provide special facilities for work outside the normal curriculum for qualified engineers. The different subjects included in the course are approached more

from the practical and the engineer's point of view rather than from the academical point of view. There are, of course, regular theoretical lectures delivered both by the teachers of the School as well as by the research engineers from the Marconi Works, who specialise in the different branches. The School also arranges special lectures by experts from other organizations like the B. B. C. and the British Post Office.

Amongst the subjects in which the author took special interest while at the School, mention may be made of the design and testing of short wave broadcasting transmitters, matching transmission lines and feeders, receiver measurements, absolute measurement of frequency, studies of radio frequency transmitting pentodes and feeding self-radiating towers. Short descriptions of the principal equipments are given below.

The model shortwave broadcasting transmitter is designed to give an output of about 500 watts. The quartz-controlled master oscillator is followed by a buffer stage and then by two frequency doubling stages. The output of the second frequency doubler feeds a single-ended neutralized r.f. power amplifier. This is in turn link-coupled to the final balanced push-pull power amplifier. The transmitter being a model one, there is provision for various types of modulation, both high- and low-level. The final r.f. power amplifier can be used either as Class-C for high-level modulation or as Class-B for low-level modulation by suitable adjustment of grid bias. There is also provision for "keying" the transmitter for telegraphy work. The transmitter also contains a built-in cathode ray oscillograph unit which can be used for checking the modulation visually. The studio equipment of the transmitter is located in a separate room of the transmitting "hut" and consists of three channels—microphone or otherwise—and a mixer amplifier. The output is fed to a line connected to the sub-modulator unit at the transmitter. In the studio this line input is also fed to a monitor amplifier having an output meter for visual inspection of line level. The studio equipment also includes a built-in beat frequency oscillator.

The transmitter for investigations on the matching of transmission lines and feeders consists of one MT 12-A master oscillator followed by a balanced push-pull amplifier with two MT 12's giving an output of about 0.5 kw. Neutralization is done first by the "cold" and then by the "hot"

process. The line can be coupled to the amplifier either inductively or capacitively.

The distribution of current along the line and the effect of various resistive terminations, including aerial loads, are studied in great detail. Both open wire and concentric feeders are studied. The properties of $\lambda/4$ and $\lambda/2$ lines as impedance matching devices are also studied. The value of any unknown resistive load is also measured in terms of the characteristic impedance (which is separately measured) by carefully noting the distribution of current along the open wire line.

In connection with receiver measurements an interesting problem is the determination of the intermediate frequency of a commercial receiver. It is well known that the i.f. circuits are first aligned and then the signal and oscillator circuits and that the i.f. adopted by the designer must be accurately known. In case this is not known, any residual misganging can be used as an indication of the nature of the wrong choice of intermediate frequency. If the i.f. chosen for alignment is greater than the designer's value then the ganging is such that for the longer wavelength side of a waveband the signal circuit demands an increase of capacity and for the shorter wavelength side a decrease of capacity for proper tuning. The reverse is the case if the selected i.f. is less than the designer's value. Thus by noting carefully the apparent demand of signal tuning capacity on the two extreme ends of a waveband (centre being properly ganged for the i.f. chosen) one can judge whether the i.f. selected is correct or above or below the correct value.

The equipment for absolute measurements of radio frequencies is the Marconi type 482-C Frequency Measuring Equipment in which the master oscillator is quartz-controlled and operates the usual multivibrator system. The lowest frequency output (100 cycles/sec.) from the system drives a synchronous clock, the time-keeping of which provides an exact indication of the master oscillator frequency. The frequencies of British and Continental stations are measured with great accuracy and their short-time variations are also studied. The variations of the frequency of an oscillator with electrode voltages and with loading are also studied with this equipment. It may perhaps be of some interest to note that the B. B. C. also use one such equipment at their frequency checking station at Tatsfield. The British Post

Office also uses this system at Baldock for routine measurements of the frequencies of all British (also Continental) stations.

The feeder used in connection with investigations on feeding self-radiating towers is of the concentric type. Matching is effected by means of the so-called reactance transformer. The towers are usually insulated from the ground and the first step for matching adjustments is to measure with a R.F. bridge the resistive and reactive components of the impedance between the aerial base and earth. From the known characteristic impedance of the concentric feeder the components of the reactance transformer are calculated. With these components the final matching is tested with the help of an impedance matcher.

E. K. COLE, LIMITED.

The next important establishment visited was the Factory and Development Department of E. K. Cole, Ltd., Southend. This firm is one of the biggest manufacturers of broadcast and television receivers and is the pioneer manufacturer of radio communication instruments in Great Britain. The activities of this organisation are divided mainly into two sections. One is known as Government Contract and Instruments section, and the other as Receiver Manufacture section. The author was privileged to work in both the sections and got thorough acquaintance with their activities. It may be noted that the instruments manufactured by this company are marketed as Marconi-Ekco instruments.

Government Contract & Instruments Section.—

In this section the author was mainly interested in the development, testing and standardization of measuring instruments as are used in wireless and acoustics. Of the instruments critically studied mention may be made of standard signal generator of all frequencies, beat frequency oscillator, wave analyzer, Q-meter, impedance measuring bridge, attenuator, distortion factor meter, wavemeter and thermionic voltmeter. The details of design and methods of standardization of these instruments are beyond the scope of this article and the author therefore refrains from making any special references.

Receiver Manufacture Section.—This section is concerned with the manufacture of both broadcast and television receivers. Some components, such as coils, r.f., i.f., and l.f. transformers, power transformers, chassis, bakelite cases, etc., are manufac-

tured in the Company's factory. For testing and calibration, instruments manufactured by the Instruments Division are used as far as possible. It may perhaps be mentioned that so far as receiver manufacture alone is concerned this is one of the biggest of such factories in Great Britain and the author had the opportunity of studying the different stages in the manufacture and testing of commercial receivers in mass production. A brief description of the method of manufacture may perhaps be interesting.

Any particular type of receiver is first designed and fitted up in the development section where preliminary tests are made. Next, this receiver is passed on to the regular commercial testers in the manufacturing section where further tests are made specially from the commercial and servicing point of view. The remarks of these testers are then passed on to the development section where some further additions and alterations are usually made. After these preliminary trials a number of such receivers are built on a semi-commercial scale and if these are found satisfactory and marketable then and then only real mass production begins. These remarks hold for both broadcast and television receivers.

The manufacture of a receiver may be broadly subdivided into several distinct stages. First comes the assembling of all the components on the chassis. This assembled unit is then passed on to the mechanical tester who tests the components and fittings from the mechanical point of view. After this, the connections are made—the entire process being on the "belt" system. The chassis with all components mounted is made to pass slowly on a belt, the motion being discontinuous. Each individual working in the chain is entrusted with a certain number of specified connections and is allotted a definite time during which these have to be finished. At the end of this period the receiver is passed on the belt to the next person who in turn does the connections entrusted to him. In this way the receiver passes on to the end of the belt where once again all the connections are checked from the mechanical point of view. Next it passes to the first tester who tests the power consumption, preliminary alignment and other minor tests. Finally it goes to the last tester a short description of whose equipments and method may be of some interest. This tester has on his bench permanently mounted a number of testing instruments and also supplies of

audio, radio and intermediate frequencies. The main instruments are one standard signal generator, one output meter, one avometer and one mains consumption meter. The audio, radio and intermediate frequency supplies are generated centrally in screened rooms and are of sufficient power to feed all the testing benches where these are wanted. The supplies are given by means of screened cables to avoid any interference. With the help of the mains consumption meter, the tester first checks the consumption to see if it is normal. Then, applying the calibrated audio supply, he measures the output. If this is within the prescribed limits he proceeds with the alignment of the i.f. circuits and then the A.F.C. system, if there be any. When these are done the signal and oscillator circuits are adjusted carefully. Finally the receiver is taken to a cabin for tests with actual broadcast stations. The cabin has got a supply of continuously varying audio frequency from a central source in the factory. With the help of this, the i.f. response of the receiver is tested aurally and then the aerial tests are made. The actual aerial is located far away from the workshop and in the open ground in order to avoid the local electrical interference from the various factory plants. The lead-in is taken to the cabin by means of screened cables. The receiver is now passed on to the cabinet fitting section where it is completed in the form available in the market. To test the mechanical stability of the receivers due to probable bad handling during transport, some of the receivers are made to undergo a special test. The finished receiver is packed in its box and by means of a machine operating automatically it is raised to a certain height and thrown down at random on the floor. This process is repeated for a certain number of times and the receiver is then unpacked and again tested. After this final test it is ready for the market.

RESEARCH STATION OF THE BRITISH POST OFFICE AT DOLLIS HILL

The next important establishment visited was the British Post Office, firstly their Research Station at Dollis Hill and then their Transmitting and Receiving Stations at Rugby, Baldock and St. Albans.

The station at Dollis Hill is maintained by the Post Office for investigations on problems connected with the various communication systems maintained by the department. New apparatus required in the different services are designed and developed here. The activities of the Station may broadly be classified

under the two heads—telephone and radio. In the telephone section the author was primarily interested in its acoustic work; he also followed their methods of testing the articulation of lines and other networks and, also, the mass-testing of telephone receivers under all possible operating conditions.

In the acoustic department, microphones, telephones, loudspeakers and other similar equipments are designed, tested and calibrated. This department also carries on work on studio design, auditorium testing, noise measurement and tests of telephone lines and associated gears. Sound-on-disc recording for the Post Office is also done here. For the purpose of quantitative measurements on electro-acoustic apparatus, *e.g.*, absolute calibration of microphones and loudspeakers, the department has built an acoustic cabinet. The design of this cabinet (a similar one is being used by the B. B. C. at Nightingale Square, London) has been made very carefully and is almost 'dead' acoustically. The cabinet is provided with a point source of sound of special design which generates spherical waves.

For "free air" calibration of microphones this source is used in conjunction with a Rayleigh disc. Sometimes a substandard condenser microphone calibrated by the N. P. L. is also used for comparison. For "pressure" calibration the Rayleigh disc is also used but under different conditions. For this purpose a system of plane standing waves is maintained in a resonating closed air column, at one end of which (a position of maximum pressure) the microphone under test is placed. This end is made air tight with plasticine. The Rayleigh disc is placed at a position of maximum velocity, generally at the midpoint of the column. To the other end is fixed the source of sound, a watch type telephone receiver. Both ends of the resonating tube have telescopic adjustments.

This acoustic cabinet is also used for loudspeaker testing. The loudspeaker is suitably placed in the cabinet and is fed by an amplifier located outside; the input of the amplifier is supplied by a beat frequency oscillator of uniform characteristics. The sound emitted is picked up by a calibrated condenser microphone connected to an amplifier placed outside the cabinet. The output of this amplifier operates the recording rectifier-galvanometer system. The record thus obtained by varying the frequency of the oscillator gives the overall response of the entire chain of equipments used. Another similar record is taken which gives the combined characteristics of

the oscillator and all the amplifiers involved. From these two records and from the known characteristics of the microphone, the actual loudspeaker response is obtained.

An important measurement in connection with studio design is that of the reverberation time. For this purpose the Post Office makes use of both objective and subjective methods. For objective measurements a special bridge circuit developed at the Post Office is used. The apparatus gives very good results when the rate of decay of sound in the studio is exponential. In general, the decay is not exponential and some difficulty is experienced in maintaining a proper bridge balance. This is obviated to a great extent by making the source of sound rhythmic over a short range of frequencies round that at which the test is desired.

The subjective method is straightforward and hardly needs any explanation. It has been found that a reverberation time as small as 0.5 second can be easily measured with a certain amount of practice. This method has the advantage that the reverberation is directly related to its effect on the ear. It might seem that a large room with adequate absorption would have the same order of reverberation time as a much smaller room with little absorption; yet it is found that the physiological effects of reverberation in the two rooms are different. A measurement of reverberation time, although the most generally useful, is not the sole criterion of reverberation *effect*, and its pursuit to greater precision by an objective method may not always be justifiable.

For noise measurements the Post Office generally use the objective method, particularly because the subjective method is applicable only to controlled sounds. The main difficulty in an objective noise meter is the introduction of a frequency weighting network in the amplifier chain in order to simulate the characteristics of the human ear. It is of interest to note that the International Acoustics Conference (1937) decided that such a weighting alone is not sufficient when impulsive sounds are concerned. It was further considered that the time was not ripe for the specification of a universal objective noise meter.

The Radio Section at Dollis Hill is mainly concerned with the development of short and ultra-short wave transmitters, receivers and other associated equipments used at the different P. O. stations.

They are now giving very close attention to the development of single-sideband short wave transmitting and receiving gears. The interference and piracy detector divisions of the P. O. also belong to this section. As is well known, the British Post Office use ultra-short waves of length about 4 metres for telephone and telegraph "links" for communication across channels, rivers, etc., where it would be costly to instal and maintain cables. During the author's visit one such equipment was being developed for a link between India and Ceylon.

For field service the British military authorities sometimes use a special type of transmitter and receiver controlled by light waves. Such services are strictly "local" and are quite beyond any possible interception by an unwanted party. The principle is that the voice from the sender operates a microphone, the output of which is amplified and then modulates a strong source of light. This light is transmitted in the form of a concentrated beam to the distant receiver, the range of operation being about 2 miles. The modulated light is received on a photo-cell at the receiver end and the message is easily obtained from same. These equipments are also developed by the Post Office.

The Radio Section also maintains a very accurate frequency standard and frequency measuring equipments. The primary standard is a valve-maintained tuning fork of frequency 1000 cycles/second determined in terms of mean solar time. The fork equipment is located in a specially designed and closed underground room in which a constant temperature is carefully maintained. It may be mentioned that a similar primary standard is maintained by the N. P. L. which regularly radiates this standard 1000 cycle note by modulating the 396 Kc/s carrier of the N. P. L. transmitter G5HW. The P. O. have recently developed a very accurate system of comparing these two primary standards to an accuracy of ± 5 in 10^8 . For short wave working the P.O. are now developing a quartz standard. The Section has got a special department dealing with quartz crystals; the P.O. crystals are now being favoured by many establishments such as the B. B. C.

THE RUGBY RADIO STATION (BRITISH POST OFFICE)

The Station, situated 90 miles from London, was originally designed for long wave radio-telegraphy communication with all parts of the world

and was inaugurated on January 1, 1926. It is now one of the most powerful of similar stations in the world. With the development of radio-telephony, a long-wave transatlantic telephony service to America was opened on January 7, 1927. From economical consideration it was not possible to extend this long-wave telephony to more distant places as it was soon found that with the use of efficient directional antenna systems, short wave telephony services could be established much more economically for linking England with practically any part of the globe. The Station is now equipped for both long-wave and short-wave services. It covers 900 acres of land and has got two groups of buildings. The main building houses the two telegraph transmitters G. B. R. and G. B. V. and also the long-wave telephony transmitter G. B. Y. In an adjoining small building there are two short-wave transmitters, one for Indian service and the other for service to Japan and South America. The new short-wave building contains eight short-wave telephone transmitters.

The G. B. R. (16 Kc/s) was the first high-power telegraph transmitter using thermionic valves. Both G. B. R. and G. B. V. are tuning fork controlled and the rated aerial powers are 450 and 40 kw respectively. The final amplifier of G. B. R. uses two (at times three) banks of 18 water cooled valves in parallel, each valve capable of yielding 10 kw output. Some special precautions have had to be taken to avoid the usual difficulties associated with the paralleling of high power valves. As an alternative to one of these banks, a single 250 kw valve of the demountable type is sometimes used. The "keying" is controlled entirely by a small relay inserted in the grid circuit of a valve at a point where the r.f. power level is less than one watt. The transmitter frequency being only 16 kc/s, it cannot obviously be used for high speed telegraphy. In this respect the G. B. V. (78 kc/s) is superior and is equipped for high speed transmission.

The final tank circuit and aerial coils of G. B. R. are of 565/36 S.W.G. cables (about $1\frac{3}{4}$ inches diameter) wound in the form of spiders. The electric stress is so high during transmission that these huge coils shake mechanically. During experimental stages the leading-in of the aerial presented a difficult problem. The aerial was led in through a glass window; the dielectric loss in the wooden frame was so great that the wood burnt out. This has been avoided by removing the wooden frame and using, instead, an earthed guard ring.

The long wave aerial system is supported by 12 insulated masts, 820 ft. high. Each mast is provided with an electric lift capable of carrying three persons. The aerial height being very small compared with the wavelength, the radiation resistance is low and care has been taken to keep the total loss resistance as low as possible. A very efficient earth system has therefore been developed.

The G. B. Y. (68 kc/s) is of the single sideband type and is one of the most powerful telephone transmitters in the world. It was installed by the Standard Telephones and Cables, Ltd., in co-operation with the Post Office. The final amplifier panel has six 100 kw water-cooled valves of which three are used at a time and are sufficient to give full output. The transmitter is designed for an acoustic range of about 400 c/s to 2600 c/s, which is essential for fair articulation. The power delivered to the aerial is of course variable with modulation but sometimes reaches about 150 kw. It should be noted however, that this power is equivalent to that of a broadcast transmitter having an output of several times this value.

The two short wave transmitters in the small building adjoining the main one are crystal controlled and of the single side band double channel type. One of these was installed by the Standard Telephones and Cables, Ltd., and the other by the Post Office. Each is designed to operate on 3 or 4 spot frequencies and the modulated power output is about 10 kw. There is provision by which, if desired, the required aerial system can be fed from the penultimate stage instead of from the final stage of the amplifiers. From the penultimate stage an output of about 3 kw is obtainable.

The designs of the transmitters in the short wave building are practically the same as above. They are of the single side band type and balanced push-pull circuits are used throughout in the amplifiers. In the low power stages screen grid and pentode valves have been frequently used. It does not need to be emphasized that symmetry of circuits is essential for the operation of short wave amplifiers. In this connection the coupling of a single valve stage to a push-pull stage, as used at Rugby, may be of some interest. In the diagram (Fig. 1) the anode circuit of the pentode is parallel tuned and capacity-coupled to the next push-pull stage. The tuning coil is earthed (as regards r. f.) by a 0.01 μ f. condenser connected at its midpoint. The tuning condenser (series-gap type) is not earthed at any point and

this has the effect of making the oscillatory currents in the two halves of the coil approximately equal. The voltage to earth at one end of the inductance is thus equal and opposite in phase to that at the other end making the arrangement suitable for push-pull driving. To maintain symmetry of the circuit, the

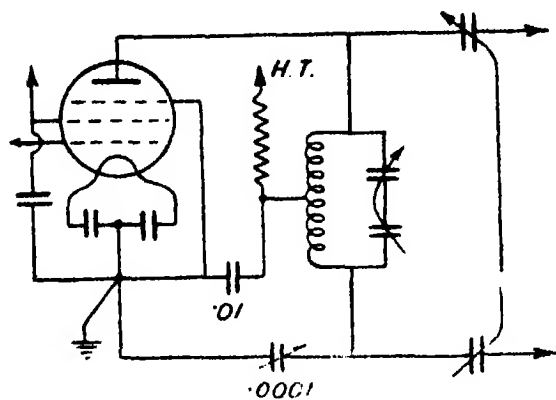


FIG. 1

capacity between anode-end of the coil and earth due to the valve, is balanced by a 0.0001 μ f. condenser connected between earth and other end of the coil. It is interesting to note the special care that is taken to make the symmetry as perfect as possible with respect to other portions of the circuit and the metal enclosure. The balancing condenser is

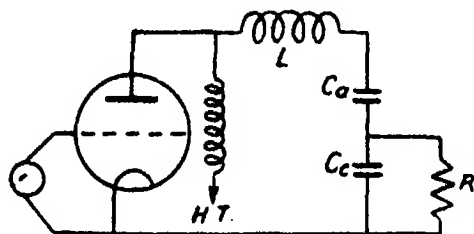


FIG. 2

made cylindrical (similar to valve electrodes) and is kept vertical and as close to the valve as possible.

Another important feature in the Post Office transmitters is the use of series-tuned anode circuit in the high power 20 and 60 kw stages. The scheme is shown in Fig. 2; only one valve of the push-pull is indicated for simplicity. It can easily be shown that in such a system the maximum output is obtained when the coupling condenser C_c is given by

$$C_c = C_a / R_v / R,$$

where C_v is the anode-filament capacity of the valve of impedance R_v , and R the load resistance. These series-tuned circuits are only possible for short

waves and with large water-cooled valves which possess a large anode-filament capacity.

It is also interesting to note that in some transmitters the 20 and 60 kw stages are built in separate "units" connected to the respective exciter stages by appreciable lengths of feeder lines. These exciters or intermediate stages are therefore designed as power amplifiers and not voltage amplifiers.

The directional aerial systems, used at Rugby are of various types, such as Sterba, Koomans, T. Walmsley, plane and cage dipole. It seems that the P. O. prefer the Koomans type specially because of its simplicity and ease of maintenance. Two-wire open transmission lines are used throughout with standard characteristic impedance of 600 ohms. The P. O. have adopted the method of matching by means of quarter-wavelength lines. The magnitude of the termination in terms of the characteristic impedance of the line is found out by noting the readings of maximum and minimum currents along the transmission line. The characteristic impedance of the matching quarter wave section is at once known and it is then accordingly designed.

THE P. O. RECEIVING STATIONS AT BALDOCK AND ST. ALBANS

All official wireless telephony communications between the United Kingdom and other countries are maintained and controlled by the British Post Office. The receiving station for the purpose is at Baldock, 40 miles from London. The station, with its large number of short wave aerial systems and one long wave aerial, covers an area of 1,000 acres. All the receivers are of the single-side-band type. The latest of these are of the Post Office (Dollis Hill) design; the earlier ones were installed by Standard Telephones and Cables, Ltd. The audio outputs of the receivers at Baldock are, for secrecy, "inverted" and are passed on directly to the Central Radio Office at London where, by suitable arrangements, the signals are made normal again. Since single-side-band reception has special advantages the B. B. C. often utilises the Baldock receivers for important foreign re-broadcasts, e.g., King George VI's message to the Empire from Canada during his recent visit there.

The receiving aerial systems used for short waves are of various types. Some are rhombics and cage type dipoles. These are generally used for a

quick search-over for a station in conjunction with normal receivers of usual design. When the station has been found or, in the case of a station radiating simultaneously on a number of frequencies, when the frequency giving the best reception has been found, the single-side-band receiver is adjusted for the corresponding frequency.

There is also provision at Baldock for checking the frequencies of the P. O. and other transmitters. There are two main equipments, one Marconi type 482C, and the other developed by the P. O. In the Marconi type each of the five multivibrator circuits are stepped down in the ratio 10:1 and each is synchronized directly by the previous stage. These make the system somewhat unstable and the multivibrators sometimes "slip" off synchronization. Moreover, the method of suspension of the quartz in the master oscillator circuit is rather unstable mechanically. The P. O. equipment, wherein quartz crystals developed at Dollis Hill are used, is better in this respect. The frequency of the master oscillator is checked by comparison with the primary standard at Dollis Hill. With these equipments the frequencies of the various British and foreign stations are systematically measured and recorded.

The receiving station at St. Albans, 14 miles from London, is meant only for radio-telegraph signals. The station occupies about 25 acres of land and some new land is being acquired for expansion. There are ten long wave and four short wave receivers, the former are of the "straight" type and the latter of the double detection type with band filters, thus giving both second channel discrimination (high i.f.) and selectivity (low i. f.)

The aerial systems are mainly supported by eight masts arranged in the form of two squares one inside the other with the station building at the centre. The four outer masts (200 ft. high) support the long wave Bellini-Tosi aeriels and also a number of open aeriels. One big rhombic is also supported on one side of the building jointly by the outer and inner masts.

The received signals are relayed directly to the central office at London, St. Albans being more or less a relay station. Each radio receiver is, however, provided with a Wheatstone receiver for monitoring by which the operator can see the signals being sent through the line.

To be Continued.

Telescope Making at Home

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THE hobby of telescope-making has gained wide popularity in America, where a large number of clubs and societies¹ have been established for the study of astronomy. There are more than two thousand members in these clubs—men and women—grinding mirrors and lenses for telescopes, with which they make occasionally interesting observations. Many interesting new stars (*e.g.*, Nova Aquila of 1918) were discovered by amateurs. In fact, the contributions of amateur astronomers and radio-amateurs

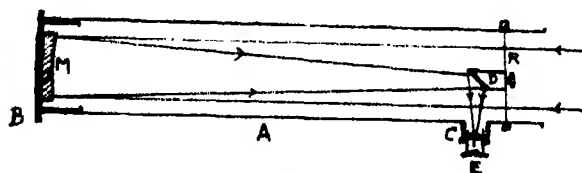


FIG. 1
Newtonian Telescope

A. Tube; B. Cap or mirror-holder; M. Concave parabolic mirror; C. Eyepiece socket; E. Eyepiece; D. Diagonal flat mirror, front surface silvered; R. Thin rod for holding D.

to scientific studies are not insignificant. Unfortunately we have no such organization in India; nor many of us have ever paid a serious attention to this matter.

In this article an attempt will be made to briefly describe the construction of reflecting telescopes at home with the minimum workshop assistance.

THE MAKING OF MIRROR AND ITS TEST

The mirror is the most important part of the telescope, and it can be made quite perfect if proceeded patiently and methodically. It was Newton who first devised the reflecting telescope, with his first mirror $1\frac{1}{3}$ inch in diameter. Thereafter many astronomers of repute found the reflecting system advantageous and made larger mirrors for themselves. Lord Rosse as early as 1845 constructed a reflector that was 6 ft. in diameter. This mirror for the first time revealed the spiral structure of the extragalactic nebulae.

But much smaller mirrors will show them up now. For, the early mirrors were not so perfect as they are now made, because the early ones were made of speculum metal (an alloy of 68% copper and 32% tin) on which thermal distortion and other distortive effects were prominent. Modern reflectors are made from glass discs which are ground concave, polished, tested and then coated with bright film of silver or aluminium. Glass mirrors are accurate, permanent, and the surface can be easily replaced by fresh film whenever necessary.

Glass of optical quality is not necessary for reflectors. Ordinary plate glass $\frac{1}{2}$, $\frac{3}{4}$ or 1 inch thick is quite suitable for making small mirrors. The ideal glass is the Pyrex, for, it has the lowest co-efficient of thermal expansion. The Chance Brothers manufacture a special type of glass for making reflectors. This has a very low expansion ranging between that of Pyrex and ordinary plate

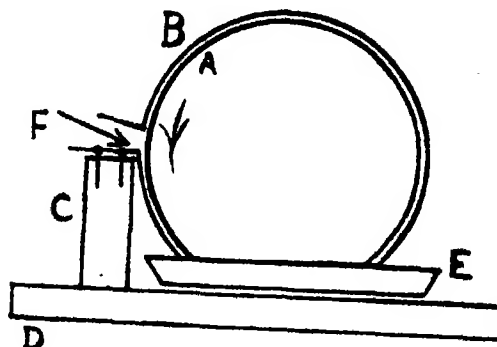


FIG. 2

Edging the rough-cut-disc.

A. Rough-cut glass disc rotated in B. B. flat iron $\frac{1}{32}$ in. thick, 2 in. wide, bent into a circle, one end nailed to C. C. Wooden pillar $2 \times 2 \times 4$ in. D. Wooden board. E. Tin tray. F. Feed for carborundum and water.

glass. A number of firms in America are now engaged in supplying 'kits' complete with glass discs and grinding and polishing materials for the use of amateur telescope makers.

Curvature Grinding: When two thick glass discs are ground one over the other (Fig. 3), with carborundum powder and water between them, the upper disc becomes concave, and the lower one convex. In fact there are three motions which



FIG. 3
Grinding and Polishing.

must be combined in order to get the proper curvature: (i) To and fro 'strokes'—centrally over each other, and making the total play equal to about the length of the disc's diameter or a little more. This is called 'full' stroke, and it is customary to refer as $\frac{1}{2}$ stroke or $\frac{3}{4}$ stroke according to the length of play relative to the diameter of the glass disc. (ii) Rotation of the upper disc about its handle axis with $\frac{1}{8}$ or $\frac{1}{6}$ turn after each stroke, and (iii) The worker going round and round the table on which the tool-disc is fitted, completely circling in 10 or 12 strokes' time. The 'strokes' brings about 'curvature' (Fig. 4), and the other two motions make it 'spherical'.

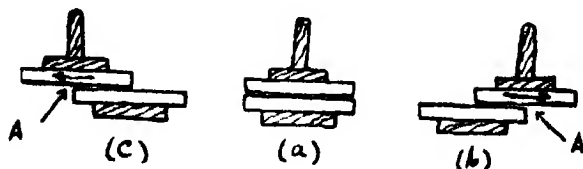


FIG. 4

How the curvatures develop.

As soon as the mirror (upper) disc passes the position (a), the edge of the lower (tool) disc begins to exert scooping action shown by arrow (A) in (b) and (c) positions.

There is no hard and fast rule for the grades of abrasive, but the following series is found to be satisfactory: Carborundum powder Nos. 60, 80, 120, 220, 3F and 303, and flour emery for the finest grinding at the final stage. The edging (Fig. 2) of the rough cut circles is quickly done by the coarsest grade No. 60, and for the finer finish it may then be

changed over to Nos. 80 and 120. The curvature-grinding may be begun with No. 60 or No. 80. It should be remembered that the work must be thoroughly washed up between the change of grades, or scratches will result. For the final stage, the flour emery is washed up by settling, as it contains coarser particles. Three tea-spoonful of flour emery is stirred up in a glass of water and allowed to stand for one minute. The upper muddy liquid is then taken off and allowed to stand for another minute. The upper liquid is again collected, and allowed to settle. The fine sediment which now settles is used for the final grinding.

A well-finished ground surface looks velvety grey and is free from scratches and pits. It would be absolutely unwise to try to save five minutes at the fine stages (3F, 303, emery), because this gain of five minutes would make for a loss of half an hour in polishing which is a tedious job.

The time of grinding depends upon the size of the mirror and the focal length desired. A six-inch mirror, which size is a good choice for the beginner, may be ground up into 48 inches focus, which means F/8. A list of mirrors and their aperture-ratios are given in the table. A 6 inch F/8 mirror will require grinding of about $\frac{1}{2}$ hour with each grade of powder. But the focus must be checked at every stage of grinding.

Checking the focus: As the grinding proceeds, the curvature deepens, and the focus becomes shorter. The focal length, which is half the radius of curvature, can be measured by a spherometer. But more convenient method is that by reflection. The glass, however, at any stage of grinding, is white and non-reflecting. But it can be made temporarily reflecting by smearing the surface with water. So long as it is wet the image of the sun can be focussed on the wall, and the distance of the image from the mirror gives the focal length as developed.

The accuracy of measurement of focus at the rough grindings (No. 60, 80) may be taken to be within 2 inches, at the medium stage (120, 220) within 1 inch, and at the fine stage (303, 3F, emery) within $\frac{1}{2}$ inch. The major part of the hollowing out is effected by full strokes with No. 60, 80 and partly by 120. The grade No. 220 also removes some amount of glass, but its chief action is to get the uniformity of curvature with $\frac{3}{4}$ and $\frac{1}{2}$ strokes. With the 3F and finer, practically no change in focus takes place.

The depth of curvature at the centre of the mirror is given by $h = \frac{r^2}{2R} - \frac{r^2}{4F}$, where r =radius of the disc, R =radius of curvature and F =focal length. Thus, for 6 inch disc, 48 inch focus, depth is less than $\frac{1}{10}$ th of an inch; it is only 0.0487 inch or 1.2 mm.

During the fine grindings, there is the danger of sticking of the discs, as the mirror and tool discs closely fit each other and produce a partial vacuum between them. This may be carefully avoided by keeping the abrasive well supplied with water. If, however, the discs stick together badly, warm water should be applied on one disc and then given a tangential thrust. This last resource helped me wonderfully in a case of very obstinate sticking.

Polishing: After grinding is over, the process of polishing will bring back the full transparency of the surface. All surfaces, whether a telescopic mirror or a spectacle lens, after being ground to the desired curvature are polished up to perfect transparency by a suitable material.

The polishing material is rouge used on a softer base such as pitch, resin, paper, leather etc. For our present purpose pitch is very suitable. It may be remarked here that the hardness and the structure of the polishing tool play very important part in the speed and quality of polish.^{2,3}

The tool disc is covered with a layer of molten pitch which is moulded into proper curvature by pressing it with the mirror. The mirror surface should be coated with rough emulsion (2 tea-spoonful of fine grade rouge and 4 spoonful water) or soap water in order to prevent the plastic pitch to stick while it is warm.

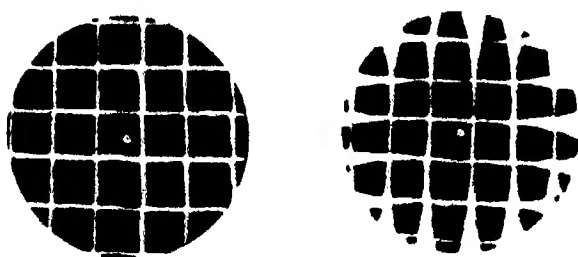


FIG. 5

(a) Polishing pitch tool.
(b) Parabolizing tool.

After getting the pitch layer uniform, it has got to be channeled into $\frac{1}{8}$ inch squares as shown in

Fig. 5(a). The squares should be decentered with respect to the tool circle. Symmetrically cut squares tend to develop defective zones on the mirror owing to the repetition of the symmetry. The channels may be cut with a hacksaw blade or a knife point with a regular supply of water to avoid chipping and clogging. Sufficient time must be allowed to equalise the temperature before the polishing is begun.

Polishing strokes are just the same as for grinding, but only that rough is now used on the pitch tool. The 6 inch disc will take about 5 hours of work to complete polishing. It is better to do the polishing job in spells of 15 or 20 minutes at a time, and then allow the work to cool. It is found that long spells develop 'hollow' and 'ring' in the centre of the mirror, which is clearly detectable under the knife-edge test. It is due to the fact that heat of hand penetrates down the handle and dilates the middle part of the mirror. This part therefore polishes out more quickly, leaving a defective hollow when cooled.

When polishing is done the next work is to test the surface for correct spherical curvature.

Knife-edge Test: A French physicist, Leon Foucault devised an ingenious method of testing mirrors. His 'knife-edge' method for testing the spherical curvature is so sensitive that it can detect a defect of radius of curvature of about 10^{-5} inch. It is sensitive enough to detect the thermal bulging of the mirror surface due to the touch of fingers for a few seconds.

The arrangement (Fig. 6) is extremely simple, requiring only a pin-hole lamp, a straight knife-edge and some means to stand the mirror vertical. The spherical mirror under test is placed on a small table with its face in the vertical plane. A pin-hole source of light is made by perforating a tin foil with a fine needle and placing it in front of the small window in a box in which an electric torch bulb is housed. An oil lamp or a candle flame may also be used. The pin-hole light is placed approximately at double the focal distance where the centre of curvature is lying; for, the radius of curvature is equal to twice focal length ($R=2F$). Now a little patience will find out the reflected image of the pin-hole formed in its vicinity. The pin-hole source is then moved until the image comes just by its side. If it were exactly at the centre of curvature of the mirror, the image would merge with the source. But this would not

allow us to make the test, so that the image should be kept as close to the source as practicable. If now the eye is placed at the reading distance away from the lamp the bright point image will be seen floating in space. But if the eye is brought too close to it, the image will blur off and the surface of the mirror will appear to be full of uniform luminosity.

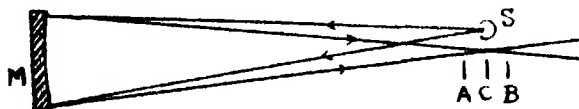


FIG. 6

Arrangement for knife-edge test.

M. The spherical mirror under test. S. Pin-hole light source. A, B, C refers to the three typical positions of the knife edge.

If a straight knife edge is then moved close to the eye to cut the reflected cone of light, a straight shadow will appear to pass across the luminous disc. If the knife edge is within the centre of curvature of the mirror (A position, Fig. 6) the shadow will travel with it. But if the knife edge is beyond the centre (B position), the shadow will travel in the opposite direction of the knife movement. A point (C position) will be obtained between these positions, where no travelling shadow of the knife edge can be recognised. The whole of the disc will then evenly darken down quickly by the slightest cutting movement of the knife. This is the true image point which would give the centre of curvature of the mirror.

When the spherical curvature is defective and there are more than one centre of curvature for different zones, no position of the knife will be found where uniform darkening down of the whole disc may be obtained. It will then be found that some portion of the disc is shaded and some portion lighted up irregularly, or there may appear illuminated or shaded ring on the mirror (see Fig. 7). The common defects are the rings (elevated or depressed), hollow in the middle, and turned down edge. The characteristic shadows are readily interpreted when accustomed to such tests.

The local corrections by pencil polisher or small tool are not necessary for small mirrors, but a little polishing continued over an altered pitch tool with careful central short strokes will cure the defects which are usually small. Details of different methods of correcting local defects are described in books referred to at the end of this article³¹⁴.

PARABOLIZING AND MEASURING THE FIGURE

When we have a correct spherical mirror, it has to be parabolized. As the parabolic correction for such a mirror is very small, there is a risk of over-doing it. Let us first see how much is the difference between the sphere and the paraboloid. For a spherical surface, each part has the same curvature and focus, but a paraboloid gradually flattens out towards the periphery. Thus the radius of curvature, hence focus also, is longer for the peripheral regions than the central part of a parabolic mirror.

The difference in the radii of curvatures for the centre and for the rim is given by $\Delta R = \frac{r^2}{R} - \frac{r^2}{2F}$, where r is the radius of the mirror disc and R the mean radius of curvature ($R=2F$). Thus for the 6-inch mirror just described, $\Delta R = \frac{3 \times 3}{2 \times 8} - \frac{3 \times 3}{8} = 0.09$ inch or 2.38 mm. A 12-inch F/6 mirror will have the difference $\frac{1}{4}$ -inch.

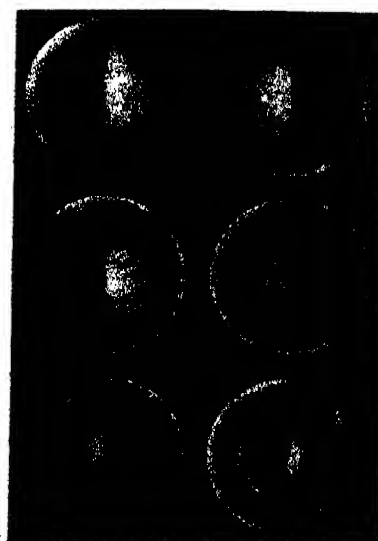


FIG. 7
Characteristic shadows under
knife-edge test.

Since the workers are more accustomed to think in terms of the 'aperture' or diameter of the disc, and 'focal ratio' (such as, F/4.5, 6, 8 etc.), $\Delta R = \frac{r^2}{R}$ may be converted in terms of A and N , where A =aperture, N =the focal number (4.5, 6, 8 etc.). Then, $\Delta R = \frac{1}{8} \frac{A^2}{N}$. Thus, for 12-inch F/6 mirror $\Delta R = \frac{1}{8} \times \frac{12^2}{6} = \frac{1}{2}$ inch and for 6-inch F/8 mirror $\Delta R = \frac{1}{8} \times \frac{6^2}{8} = \frac{3}{8}$ inch, as told before.

The following table gives the list of different types of mirrors with their ΔR values.

Aperture (inch)	Focal-length (ft.)	Aperture-Ratio (F/N)	ΔR (inch)	Remark
6	2	F/4	0.18	Short-focus R.F.T.
6	4	F/8	0.09	Beginners' first.
12	8	F/8	0.18	Common type.
28½	11½	F/5	0.70	Observatory at Heidelberg (construction by Zeiss).
39½	10	F/3	1.63	Hamburg (Zeiss).
48½	27½	F/6.9	0.87	Berlin-Babelsberg (Zeiss).
100	41½	F/5	2.50	Mt. Wilson Observatory, California.
200	55	F/3.3	7.50	Hale Observatory, Mt. San Diego.

The table also shows that parabolizing becomes more important for shorter focus and larger aperture. Parabolizing can be effected in two simple methods: (a) by changing the polishing strokes, (b) by changing the polishing tool. In any case, parabolizing is done by the polishing method and not in the grinding stage, and it is done when a perfect polished spherical curvature has been obtained.

(a) *Over-hang Method*: If the spherical mirror is now polished on the pitch tool (as it was) with about $1/5$ or $3/4$ diameter "over-hang" (Fig. 8) the

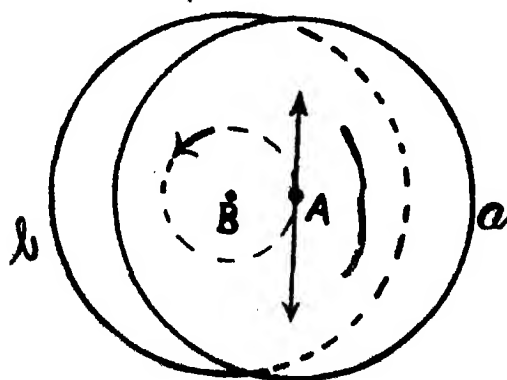


FIG. 8

Over-hang strokes

A is the centre of mirror disc a, B is the centre of tool disc b. AB gives the over-hang of the mirror across the edge of the tool. The straight arrows showing the strokes. A will move round the dotted arrow.

centre of the mirror will polish out more quickly than the outer parts tending to a parabolic figure.

Five minutes' work is sufficient to test the progress of the figure. Put about half an hour must be allowed to equalise the temperature. The measurement is done by the knife edge method. This is to measure the difference (ΔR) between the radii of curvatures for the centre and the rim of the mirror. A cardboard is taken and perforated at the centre with a $1\frac{1}{2}$ inch aperture and the mirror is covered with it. The centre of the mirror is thus exposed and the knife edge locates the centre of curvature as described in the Foucault's test. The position of the base of the knife edge is marked. Then the cardboard is removed and replaced by another having two sectors opening the extreme rims $1/4$ inch wide and 2 inch arc on the diametral ends. The position of the knife edge is marked again when both the illuminated sectors darken down simultaneously. The change of position of the knife gives the difference of radii of curvatures (ΔR).

It is however useful to under-correct the mirror due to the falling temperature of the evening atmosphere when the observations are usually taken. For plate glass mirror $1/3$ of the calculated amount may be left uncorrected. Thus, for the 6 inch F/8 mirror we may stop parabolizing when we find $\Delta R = \frac{2}{3} \times 2.38$ mm. or nearly so.

(b) *Graduated-facet Method*: The other method of parabolizing is to alter the tool. The tool used for polishing the mirror had pitch squares cut by straight channels. But now the cuts are gradually widened out at either ends (Fig. 5b). If now polishing is continued with diametral short strokes (exactly the repetition of the spherical polishing process), the sphere will tend to a paraboloid. The underlying principle is that the outer pitch squares are gradually smaller than the middle ones, so that the centre of the spherical mirror polishes out faster—tending towards a parabola.

THEORIES OF GRINDING AND POLISHING OF GLASS

After these practical hints, it will be interesting to discuss here the underlying principles. Let us first see what 'grinding' really means. Diamond is harder than glass, so that the diamond point will cut or scratch glass. As the point is dragged along the glass surface, the latter goes on breaking in fine scales. When examined under a microscope the scratch shows a series of conchoidal breaks. Carborundum is also much harder than glass, and it does the same job in grinding. When carborundum is put between the faces of two glass plates and ground on,

the grit breaks the surfaces into tiny conchoidal flakes.

It is interesting to compare the action of glass-tool and metal-tool used for mirror or lens grinding. When glass is ground on glass-tool, the carbo or emery cuts both the discs (*e.g.*, mirror and tool) equally, so that both of them take up the same curvature. But a metal-tool does not itself grind off so fast when used against glass. In fact, the softer the metal, the faster it will cut glass with an abrasive. Naturally so, because the cutting particles are embedded in the soft metal (lead, copper, brass, iron) which drags so many scratching points over the glass. There is very little relative motion between the metal and the abrasive when there is glass under them, and so the metal-tool is not put to wear. This is why copper rod or tube is preferred in drilling glass. Such drilling will be necessary for the amateur telescope-maker if he wants to make a Cassegrainian Mirror which will be described in the next part.

The phenomenon of glass polishing is rather difficult to understand. Many theories have been put forward, but no single theory has proved conclusive. At the very first sight it appears that the rouge acts as fine abrasive and cuts the rough surface so finely that the final surface becomes smooth and polished. It is surely a major operation. But rouge is not all. It has already been said that the tool (pitch, resin, felt, leather, cloth, paper, etc.) plays an important part in the speed and quality of polish.

A simple and long-standing theory is that rouge particles behave as tiny cutters. But later another theory has been advanced, which they call the 'flow theory'. The idea is that the glass-molecules are removed from the peaks of the uneven ground surface to flow into and fill up the pits below, the rouge acting as lubricant. Investigations were carried out to conclude between the 'cutting' and 'filling' action in the process of polishing, and it has been demonstrated that both the actions are present. The molecular-flow is explained by holding that the energy expended in polishing is manifested as heat which is sufficient to lower the viscosity of the glass near the surface to such a degree that the hyper thin film—'beta-layer'—can be made to flow. The 'flow' effect has been demonstrated in a very interesting way. A scratch was polished with strokes perpendicular to it, it worked out quite well and quickly. But when this area was etched with hydrofluoric acid, the scratch was again revealed.

The chemical examination of the spent rouge after polishing showed a very small quantity of silica coming out of the glass surface by the process of polishing. This by all means proves that there is some removal of glass by the abrasive action of the rouge. The removal of glass may also be concluded from the fact that a polished spherical glass mirror takes up the parabolic figure by the very act of polishing.

SILVERING

The last work on mirror is the silvering. Among other chemical processes Brashear's method is the best. The process may be found described in many books on chemistry and on laboratory technique, so that only a very brief account will be given here. A solution of silver salt is reduced to metallic silver by a reducing solution, and this silver can be deposited on a glass placed in the bath. The silvering should be done at temperatures below 18°C, preferably between 12-14°C, with the help of ice-bath. We require three solutions A, B and C as follows:

A. Reducing solution (stock)			
Sugar (ordinary clear crystal)	...	45 gm.	
Nitric acid	...	2 gm.	
Distilled water	...	500 c.c.	
Ethyl Alcohol	...	88 c.c.	

Boil the sugar, acid and water together, add the water lost by evaporation, and when cool, mix up the alcohol. Old solution works better, so prepare the stock solution a few days in advance, and stock the excess for future.

Now make the stock silvering solutions as follows:

B. Silver nitrate	15 gm. + 150 c.c. distilled water.
C. Caustic Potash	8 gm. + 80 c.c. " "

Remembering that $\frac{1}{4}$ gm. of silver nitrate is required for 1 sq. inch of surface, we shall require 7 gm. of silver nitrate (= 70 c.c. of soln., B) for 6-inch disc which has 28 sq. inch surface; and half this amount (= 35 c.c.) of solution C. The quantity of reducing solution will be 42 c.c. (6 c.c. for each gm. of silver nitrate).

The mirror surface is thoroughly washed up with soap, caustic potash 10% soln., and strong nitric acid, and finally with plenty of tap water and then with distilled water. The chemically clean mirror is then kept waiting face up under distilled water in a suitable dish.

70 c.c. of *B* is taken in a beaker and ammoniated with strong liquor ammonia. Ammonia must be added drop by drop and stirred up thoroughly. The solution first turns black, but the precipitate dissolves with excess of ammonia. When a trace of turbidity is retained the ammoniation should be stopped.

Then 35 c.c. of solution *C* is added when the solution turns again dark. The ammoniation is repeated until pale yellow or straw colour is regained. One must be very careful not to overdo the ammoniation. Now about 10 c.c. of *B* is again put into it when the whole thing turns black. The solution is then filtered and the straw coloured clear liquid is mixed up with 42 c.c. of solution *A*, and immediately poured over the mirror. The water in which the mirror was waiting need not be poured off. It will be found at once that the solution is turning black indicating the separation of metallic silver from the solution.

Silvering is complete in five minutes. The mirror is then washed under a softly running tap, and the surface swabbed lightly by a lump of wet cotton wool. The mirror is finally washed with distilled water, and dried quickly before a blower (hot or cold) to avoid the formation of yellow stain. The silver film need not be polished, for that usually means more harm than good.

To be Continued.

References.

- ¹ A list will be found in *Scientific American*, 152, 265, 1935.
- ² *Dictionary of Applied Physics*, Vol. IV (Glazebrook), under the head 'Optical parts, the working of'.
- ³ *Procedures in Experimental Physics*, Chap II—John Strong (1939).
- ⁴ *Mirrors for Telescopes*—McHardie (1937).
- ⁵ *Scientific American*, 159, 336, 1938.

LAZY CORN EXPLAINED

Lazy corn, that sprawls flat on the ground instead of standing erect, is given a physiological explanation in *The Botanical Gazette*, by Dr John Shafer, Jr, of Cornell University.

If a normal cornstalk (or any other plant) is laid horizontally, about 60 per cent of its auxin, or growth-promoting hormone, becomes concentrated on the lower side, making that side grow faster and causing the stalk to curve upward into normal position again.

In lazy corn this condition is reversed. The plant perversely concentrates 55 per cent of its hormone on the upper side of the stalk, keeping it in its prostrate position.

Laziness in corn is a hereditary defect. Such corn is useless for practical purposes and is grown only as a curiosity.

—*Science Digest.*

Silvicultural Researches in India

SILVICULTURAL research is concerned with the whole of the production side of forestry. If forests are to be managed commercially so as to produce the maximum net returns to their owners, it is necessary to have detailed silvicultural knowledge of how the forests should be treated from the time of sowing the seed until the trees are finally felled. It is the constant aim of silvicultural research to improve the productivity of all land dedicated to the growing of forest crops.

REGENERATION EXPERIMENTS

It is axiomatic that a forest cannot be worked continuously without degradation unless young trees are established to take the place of those felled. In the mixed tropical evergreen forests, of parts of Madras, Bombay, Assam and Bengal, for instance, no intensive working was possible up to within recent years because we did not know how to regenerate them, and consequently the returns from this type of forest were very low. Intensive silvicultural research has recently shown how a certain degree of success can be obtained by planting valuable evergreen species under high top canopy shade, or by the use of auxiliary shade crops and as a result more intensive exploitation is now possible with correspondingly improved financial returns, and furthermore, the new crops that are being raised will have a higher proportion of valuable species in them than the original forest.

IMPROVEMENT OF DRY FUEL FORESTS

Another example of silvicultural research stepping in to save a difficult situation is in the fuel forests of the hot dry localities in South India and elsewhere. Previously these forests had been worked by clear felling on a short rotation of 30 to 40 years, relying for regeneration on the sprouting of the stumps of the trees ("coppicing") together with a certain amount of new regeneration from fallen seed. Statistical studies by the local Silviculturist elicited the fact that these forests were gradually deteriorating under the treatment then in practice. After 10 years of intensive silvicultural research it has now been discovered how to raise at an economic cost

many of the more important firewood species under conditions of great heat and very low and irregular rainfall. As a result, it is possible to continue intensive working of these forests which are vital to the local population, supplying their requirements of fuel and small timber; and instead of the forests deteriorating and annual yields becoming less and less they are now being improved.

REDUCTION IN PLANTATION COSTS

Silvicultural research is constantly at work on problems connected with the reduction of costs of plantation operations. Studies have to be made of the best ways of getting seeds to germinate, the best quantity of seed to use in nurseries and in the field, improved methods of sowing, whether to shade or not, whether sowing should be done direct in the plantation, or whether nursery raised transplants or "stumps" (root and shoot cuttings from nursery seedlings) should be used, what size of seedling or stump is best, what is the best season for planting, how much, or rather how little soil working and weeding is necessary, and so on. A mistake in any one of these details may make all the difference between a successful plantation and an expensive failure. A recent example from teak plantation research illustrates this point. Experiments carried out over a period of 5 years in 4 or 5 different localities in the west coast districts of Madras showed that if "stumps" of teak of a certain range of size (0'4"—0'8" diameter) were planted out six weeks before the monsoon, and a certain type of weeding by scraping was done, the resultant growth was so rapid and the gain in survival percentage so great that the total cost of formation was reduced by Rs. 5/- to Rs. 12/- per acre.

SUITABLE TREES FOR PLANTATIONS

Silvicultural research is constantly engaged in determining what species are suitable for different soils and climatic conditions. Whenever any species is found by the utilisation experts to be specially good for any particular industrial purpose (*e.g.*, matches, paper-making, plywood, tanning bark etc.), the silviculturists in the different provinces in India set to work to determine the silvicultural requirements

of the species and to work out the best plantation technique for it. Similarly any species for which a local demand exists or springs up is fully investigated by the silviculturists.

AFFORESTATION EXPERIMENTS

There are large areas of India where the soil is too poor or the climate too dry for any form of agriculture, or where, owing to destruction of the forest in the past locality conditions have changed for the worse. Instances are the "Bhur" and "Usar" areas of the United Provinces, the "Kallar" areas and the eroded areas of the Siwaliks in the Punjab, dry barren areas in parts of Bihar and Bombay, shifting wind-blown sands of the south of Madras and in Orissa, high-level grass-land in the Nilgiris, etc. Silvicultural research is constantly at work trying to find suitable species and suitable methods of afforesting such localities, and notable advances have been made in this direction in recent years.

NATURAL REGENERATION EXPERIMENTS

Where "natural regeneration" (*i.e.*, the regeneration of crops from natural seed-fall or sprouting of stumps with little or no planting) can be achieved it is generally cheaper than making artificial plantations. It is, at the same time, an operation requiring a considerable amount of skill and silvicultural knowledge, and involves such operations as manipulation of the forest canopy to the correct degree, burning or alternatively fire protection, grazing to keep down grass, or alternatively fencing to prevent browsing, weeding at critical periods and other operations for producing conditions favourable for the germination of the seed and the establishment of the seedlings. Experiments to ascertain the effects of the numerous controllable ecological factors in the forest on the recruitment and establishment of reproduction of desired species form an important part of the programmes of research of the silvicultural branches in the provinces, and have as their aim the development of a cheap and successful technique for regenerating the forests in question by natural methods.

TENDING AND THINNING EXPERIMENTS

Tree crops once established have to be tended and thinned in such a way as to produce the maximum quantity of the desired form of produce—be it firewood, clean timber, bark for tanning, heartwood for extraction of valuable product, etc. Silvi-

cultural experiments are in progress in crops of a great number of the more important economic species to determine the best intensity and periodicity of thinning, and the best type of thinning in each case.

VARIETAL TRIALS

Just as in agricultural crops, trees of one species may vary very considerably in their properties, and in such variations are often hereditary. For instance, Chir pine trees vary in their resin producing capacity and sometimes have badly twisted fibre. *Acacias* producing tan barks vary in the tannin content of the bark, teak trees of different origins vary in growth form, branchiness, fluting of the stem, rate of growth and in frost-tenderness, individual trees occur in many species which have valuable ornamental figure, or alternatively bad characters like interlocked grain. There is an enormous field for silvicultural research in determining to what extent desirable or undesirable characters are inherited or not and in isolating and breeding strains of trees having valuable properties and in eliminating strains which have undesirable ones. A considerable amount of work is already in progress with these objects in view.

MANAGEMENT STATISTICS

For the proper management of forests, so as to produce the highest sustained returns, detailed statistical knowledge of the growth of crops throughout their lifetime is fundamentally necessary. The determination of the most profitable age or size at which crops should be exploited and the calculation of the permissible yield that may be extracted annually from the forest without encroaching on the growing capital are dependent upon these statistics. In even-aged crops and plantations they are collected by the periodic remeasurement of small sample areas distributed over the full range of age classes and of soil and site quality classes. There are, at the moment, about 1,983 such sample plots under measurements, the data from which are all computed and compiled into yield tables in the statistical section of the Silvicultural Branch of the Forest Research Institute. Statistics for increment in irregular forests and in mixed crops are similarly collected, as well as data for determining the cubic contents of standing trees. These "volume tables" as they are termed are essential for the satisfactory organisation on exploitation work, and enable contractors to know what output of round logs or of sawn timber may be ex-

pected from the standing crops they have purchased. Bark percentage and heartwood percentage data are also utilised.

Statistical management studies are also made in other types of crops, a notable example being bamboos worked either for paper making or for supplying local markets. Here it is necessary to determine the best method of regulating cutting so as to obtain the maximum output of the required type of bamboo, and also to obtain statistics of the yield per acre of properly managed bamboo forest.

PROTECTION PROBLEMS

Forests suffer from numerous enemies, the greatest of which is mankind himself. Apart from insect pests and fungal diseases, which are dealt with by the *Entomologist* and the *Mycologist* respectively all other protection problems, such as prevention of damage by wild or domestic animals, protection from fire, the eradication of parasitic plants, weeds and pests such as Lantana and Eupatorium, climbers etc., fall to the Silviculturist for solution, as also problems concerned with the maintenance or formation of forests for flood prevention and for checking erosion. Studies of grassland improvement and grazing management in connection with forestry have recently

come within the sphere of the silviculturist's problem of work.

DOCUMENTATION AND SUPPLY OF INFORMATION

The field covered by silvicultural research has been indicated in the above very brief account. When it is realised that there are several hundreds of economic species in India under investigation at any one time, the wide scope of the work can be appreciated. The investigations, which have of necessity, mostly to be conducted in the forests themselves by local silvicultural research workers are co-ordinated through the Central Silviculturist at Dehra Dun, and all results of investigation as well as all other useful silvicultural information is systematically placed on record, and is available for replying to the numerous enquiries received from private individuals as well as from official sources, and from abroad as well as in India. The function of the silviculturist's office as an information bureau is an ever increasing one, and one which owing to shortage of staff, has not been able to expand sufficiently to meet all demands made on it.*

* Kindly communicated by the President of the Forest Research Institute, Dehra Dun.

Notes and News

Obituary

SIR JOCKLYN FIELD THORPE died suddenly on June 10 last, at the White House, Sussex. Born in 1872, he was educated at King's College, London and at the Royal College of Science. He later took a Ph.D. degree working under Victor Meyer at Heidelberg. In 1895 he joined Owens College, Manchester as a Fellow and remained there for 15 years. He came under the influence of W. H. Perkin (Jr.) and jointly and alone published papers on subjects which served later as the foundation for many of the modern developments in organic chemistry. After the expansion of the Imperial College at South Kensington he was appointed a professor in 1914 where he remained until his retirement in 1930. Here he trained a large number of students and played no insignificant role in placing his country in the leading position in organic chemistry which it occupies today.

Thorpe had a passion for the advancement of chemistry on co-operative lines and he made a great effort to unite various chemical interests. He was a member of almost every chemical committee set up during the last 25 years and also served as president of both the Chemical Society and the Institute of Chemistry.

Monograph on Excavations at Harappa

A DETAILED account of discoveries made at Harappa, in the Punjab, has recently been published by the Archaeological Survey of India in a sumptuously illustrated monograph on Excavations at Harappa. The excavations at Harappa were carried out first by the late Rai Bahadur Daya Ram Sahni and then by Mr M. S. Vats, Deputy Director General of Archaeology, who has edited the publication. The present volumes together with the previously published 5 volumes on Mohenjo-daro by Sir John Marshall and Dr Mackay complete the official account of the large-scale excavations in the Indus Valley. The discoveries at Harappa range over a period of 20 years. We hope to publish a review of the monograph in a subsequent issue.

Harappa which has been known for over 100 years, is larger in extent and had a much longer span of life than Mohenjo-daro, and reveals phases which are definitely earlier as well as later. Amongst the earliest finds at Harappa are miniature seals and sealings dated to the second quarter of the 4th millennium B.C., a period not reached at Mohenjo-daro. These seals are generally of burnt steatite, less frequently of faience or paste and rarely of shell and are characterised by the absence of any knob, and also of the unicorn and other animals, (with the sole exception of the *gharial*), found on the later stamp seals. The range of their inscriptions is limited, but the variety of their shapes is truly amazing, over 20 varieties having been traced out by now.

The cemetery at Harappa is unique in India, but it belongs to a distinctly later period. The cemetery contains two strata one above the other; the upper one of pot-burials which contained human remains including skulls and a few bones, and the lower one of earth-burials consigned to graves in the ground and accompanied generally by grave furniture which the dead person was apparently believed to require. The burial pottery is of finer grain and the shapes are more highly developed and elegant than in the secular pottery found in the city sites. The paintings on the burial pottery show preference for animal and realistic motifs such as the goat, deer, bull and peacock, kites and fish, as well as for plants, trees, leaves and stars, while the paintings on the secular pottery show a bias in favour of geometrical and linear patterns. A study of the skulls by anthropologists has revealed that all the principal racial strains in India were represented in the population of those early days.

In the city site, a remarkable discovery is the Great Granary, the largest of the buildings left over from the old days. The Granary consists of two similar blocks separated from each other by an aisle 23 feet wide, which was once roofed over. Each block comprises six halls, alternating regularly with five corridors, in all cases the walls rising to a uniform height. The halls are each partitioned into

four narrow divisions by three equidistant full-length brick walls terminating in broader piers. The resulting aperture made their spanning by corbelling or timbering easy. This extraordinary complex measures 169 feet by 135 feet. The halls had no doubt timbered floors which rested on the partition walls below. Access to them could be had direct from the corridors, which probably sloped up to the entrance hall, or from the aisle side. In some of the Roman Forts in England there are structures remarkably like this Granary with the same narrow galleries and the same small apertures at the bottom of the end walls intended to allow circulation of air under the floor to prevent the grain becoming mildewed.

Another discovery at Harappa is what may be called the Workmen's Quarters, giving distinct evidence of careful planning far ahead of any contemporary attempt. Fourteen small houses built in two blocks of seven houses each, separated by a long narrow lane, with a similar lane at either end have so far been brought to light. The three lanes are regularly intersected by a series of six cross-lanes, having the effect of making each dwelling open on all sides. Each house is rectangular and consists of a courtyard and two rooms, viz., a small room flanking an oblique entrance passage and a bigger room at the back of the courtyard. The entrance is so planned as to shut out a view of the courtyard from the outside. The houses bear a striking resemblance to the workmen's cottages at Tel-El-Amarna in Egypt (which date to a period at least 1200 years later), except that the cottages at Tel-El-Amarna being built in continuous rows, have no cross-lanes and are open on two sides only.

Among other important finds from Harappa mention may be made of two small nude male stone statuettes in the round of prehistoric origin. One of them is a torso, with frontal pose, in red sandstone and the other an ithyphallic dancer in dark grey stone. They are made in parts and are of high artistic merit with refined and wonderfully truthful modelling, incomparably superior to the statuary found at Mohenjo-daro. Their discovery has, in effect, revolutionised existing ideas about the origin of Indian art and its technique.

Jewellery and Crafts in Harappa

A REMARKABLE collection of jewellery consisting of gold, silver, stone, faience and shell objects, has been found below the foundation of a wall in the Workmen's Quarters. Those of gold comprise a hollow armlet and bangle, a conical ornament for the temple or forehead, a heart-shaped pendant

inlaid with blue faience, a brooch with silver backing shaped like the number 8 and inlaid with two rows of tiny, cylindrical steatite beads, having gold ends, a necklace consisting of 240 beads in four strings, two wristlets of beads and two small conical bosses, and an assorted string of 27 beads. One broken silver bangle, numerous fragments of another, six necklaces consisting of pendants and other beads of gold, steatite, agate, jade, blood-stone and faience, three necklaces of cornelian and two each of steatite and faience and one of shell complete the lot.

Another important discovery is a medium-sized, round copper jar, sealed with a lid, which concealed a hoard of implements and utensils in excellent preservation, and a small copper chariot. The former contained as many as 70 weapons and implements and several hollow and solid bangles, ready as well as in the process of manufacture. A complete idea of the ancient carts, with its roof and driver is given by the models in copper, recovered from Harappa. The Harappa chariot is two-wheeled, open in front and back, but has a gabled roof which, with the side-walls, is relieved with simple linear decoration. The driver is seated in front on a raised seat, but the animal yoked to it (no doubt a bullock, as the horse was unknown), the poles, wheels and the axle are missing. These earliest Indian vehicles are, if anything, superior to the crude carts of rural Sind in the present day.

Evidence of a highly developed ceramic and metal industry is afforded by 16 small furnaces, more or less fragmentary, found at the place. One of these consists only of a round pottery jar; two of cylindrical pits dug in the ground, the pit in one case being brick lined; and thirteen pear-shaped pits,—eight with and five without brick lining—in some cases provided with a small rectangular pillar with an air passage for the circulation of heat, and in one case with a dividing wall.

The furnaces give indications of varying degrees of heat and of repeated use. From their small size and signs of intense vitrification the conclusion has been drawn that the furnaces were not used for firing ordinary pottery ware but were designed for the casting of metal objects, which, there is abundant evidence to show, were manufactured locally or for the firing of small faience objects such as miniature vessels, squirrels, rams, beads, sundries for inlay, jewellery of this material and stoneware bangles; as well as for glazing steatite seals, faience sealings, vessels, etc., for putting on bands of coloured frit on some faience vases; and for etching cornelian bead—processes which imply efficient arrangements for quickly reaching a very high

degree of heat and equally rapid cooling arrangement in order to keep the colours bright. To judge from the light weight of the ashes and the intensity of the fire, charcoal seems to have been used in most cases.

War Economy and Utilization of Waste

THE annual national expenditure of the British Government was £1200 million during the year before the outbreak of the present war. During the present year it has jumped up to £4000 million. Even increased war time effort can meet only a fraction of this increased expenditure so that the nation is exploring all means of practising strict economy and to avoid waste of any form. Waste household products which in ordinary times were consigned to flames or the rubbish heap are now going to be gathered up and utilised as raw materials for other valuable products. A special department of the Ministry of Supply—the salvage department—has already been set up to cope with the problem. Some figures will give an idea of what huge preventable wastes were going on in that country before the war. Over a million tons of paper and cardboard were thrown annually into Britain's dustbins and during the present year the monthly tonnage of waste paper collected rose to 9,000 tons. Cotton rags usually considered absolutely useless and worthless are used in the manufacture of high grade paper and the industry has flourished in West Riding of Yorkshire for a long time. The industry had to depend on imported supplies, but collection of old and long discarded clothes will now make a substantial increase in home supply.

Various uses have been found for different types of animal and vegetable refuse, *e.g.*, the household cooked bone had scarcely any value at all. One eighth of its weight is fat, one-eighth glue, and the remaining three quarters after treatment will now yield food for cattle or fertilizer for the soil. So much importance has been attached to the utilisation of wastes that the Ministry of Supply has now announced that all local authorities with populations of more than 10,000 will have to arrange efficient systems of salvage and householder in these areas will be obliged to co-operate in the collection of waste paper and cardboard, scrap metals and household bones and other materials which may be added to the list from time to time.

New Method of Rendering a Poisonous Snake Harmless

THE usual method of rendering a poisonous snake harmless by extracting its fangs disfigures the

snake and sometimes even its habit seems to change. Recently an electro-coagulating device for rendering poisonous snakes harmless, has been perfected by Duval B. Jorxos, in which he employs a high frequency current of about one million cycles per second. The escape of the venom from the poison gland and its passage to the fang is prevented by the destruction of a portion of the duct. An account of how the operator can manage the entire operation without assistance and in safety has been given in *Zoologica* of March, 1940. Already a number of snakes ranging from eight inches to four feet were treated by the above method and were found to be thriving quite normally without being in any way disfigured or their habits having changed in any way. Observations continued over a year indicate that the result of the occlusion of the duct is permanent.

Energy Distribution in the Ultra-violet Solar Spectrum

A REPORT on the energy distribution in the ultra-violet solar spectrum has been published by R. Petit in *Astrophysical Journal* 91, 159, 1940. The report embodies five years' work at the Mount Wilson Observatory. The radiation from the centre of the sun's disc were used and the light was fed from an aluminized siderostat mirror through a double quartz monochromator on to a vacuum thermopile. The results, reduced to no atmosphere yields spectral energy curves showing intensity drops by 50 per cent. between 4000Å and 3800Å, remaining nearly constant to 3250Å, and then again falling at a linear rate to a low value at 2920Å. The effect of Fraunhofer line absorption was eliminated so far as possible by obtaining auxiliary energy curves with a 21 ft. grating monochromator and a photocell. Even then the curve showed most of the depressions noted by previous workers and is far removed from that of a black body. The absorption spectrum of ozone is not sufficient to account entirely for the form of the curve and its departures from the black body type seems to be real.

Large-Screen Television Projection

Up till now television has suffered from this disability that the pictures received are not comparable in size and brightness with those produced by the cinematograph. This can never be achieved until it is practicable to apply the principles of optical projection of the pictures using a standard form of light source of a suitable magnitude. Dr A. H. Rosenthal has developed an instrument, which he has termed 'Skiatron' which makes possible such projection without using any intermediate film on

which the picture is to be photographically recorded and then projected. The principle of the device is based upon the fact that certain materials like potassium chloride, normally transparent become coloured and more or less opaque when subjected to cathode ray bombardment. In the Skiatron the cathode ray receiving tube is replaced by a plate of potassium chloride crystals mounted between two transparent electrodes. As this plate is scanned by the electron beam an opaque deposit is produced, the density of which is everywhere proportional to the instantaneous intensity of the beam. The screen thus carries during each frame period of complete quasi-stationary picture, which may be projected optically like a cinematograph film. The opaque deposit may however be quickly removed by the application of an electric field between the electrodes placed on either side of the crystal. The speed of obliteration depends on the field strength and temperature of the crystal and in the instrument, these are so adjusted that the deposits are removed in the interval between successive scanings. One additional advantage over the usual cathode ray tube arrangement is that in the latter the picture projected on the fluorescent screen is continuously varying whereas in the Skiatron the picture is quasi-stationary and the picture repetition frequency used in the Skiatron can be reduced to a value just sufficient to avoid flicker. Dr Rosenthal has also devised an arrangement of using three of these tubes for reproduction of coloured pictures.

Aero-medical Research

SOME time ago Colonel Lindbergh emphasized the necessity of increasing the facilities for research in various fields connected with aviation and also pointed out that one of the fields very much neglected was that of aero-medical research. The effects of anoxemia (insufficiency of oxygen) at high altitude are known for a long time, but it is only within the last two or three years that any real advance has been made in perfecting the apparatus for administration of oxygen to pilots and passengers of air planes. Boothby and others have developed a type of apparatus which requires only one quarter as much oxygen per minute per individual of what was previously required. The other important problem is connected with the rapidity of ascent. At present a rate of ascent of one mile per minute has been reached. But how fast can the human body be decompressed from full nitrogen saturation at sea-level? Tables of decompression have been worked out for pressures higher than one atmosphere in the laboratory of the experimental diving unit but no data is available for pressure below one

atmosphere. This problem needs immediate investigation and the Mayo Foundation has installed a pressure chamber for this purpose in the laboratory of metabolic investigation to study how fast the human body can be decompressed without injury both at high and low pressures. The Foundation also proposes to start other phases of aero-medical research connected with the transport of patients safely by air.

Award of Franklin Medals to L. H. Backeland and A. H. Compton

THIS year the Franklin Institute bestowed its highest award upon Leo Hendrik Backeland, the inventor of bakelite and Arthur Holly Compton whose work on X-ray and cosmic rays has won for him an international reputation as a physicist.

Dr Backeland though best known as the inventor of bakelite, has made important contributions in other fields. A native of Belgium, Dr Backeland came to U. S. A. in 1889 and was employed as a chemist in one of the largest photographic supply house in the country. Later in collaboration with L. Jacobin he started manufacturing photographic papers and chemicals and one of their products 'Velox' paper was considered as a distinct step forward in the art of photographic printing. Later they sold their manufacturing concern to Eastman Kodak Company and Backeland turned to chemical research. His most important work was the discovery of the chemical reaction between carbolic acid and formaldehyde. By heating the product of this reaction under pressure he obtained an insoluble solid with an appearance like amber or ivory, which was easy to mould, was resistant to moisture and to chemical reagents and which did not conduct electricity. This invention was the beginning of the modern plastic industry.

The award to Dr Compton was in recognition of his brilliant researches on X-rays, in particular for his discovery and theoretical treatment of the Compton Effect. Only ten years after his graduation from the College of Wooster in 1913, Dr Compton was appointed professor at the University of Chicago which position he still holds. He has been the recipient of many honours and awards including the Nobel prize in physics in 1927. Dr Compton's early work on the total reflection of X-rays incident upon a metallic surface at a very small angle led to a new method of measuring the wavelength of X-rays, the results of which are more exact than those obtained by the earlier Bragg method. In 1923 Dr Compton investigated the nature of X-rays which had been scattered by matter.

His photographs showed the existence of scattered rays, a part of which showed no change of wavelength and another part showing a modified wavelength. Application of the quantum theory led to equations which were supported by experiment. Thus Compton not only discovered a new phenomenon but also gave it correct theoretical interpretation. In recent years his chief work has been in the field of cosmic rays.

Liaison in Scientific Work

PROFESSIONAL men in industries may be sometimes faced with problems about which they lack first hand experience and in times of emergency this handicap is likely to retard the speed and progress of work. To deal with such difficulties with regard to technical problems the Institute of Physics, London, has recently formed a panel of consultants out of which the physicists who are likely to offer immediate practical suggestions are put in touch with the enquirer. The preliminary contact is quite informal; subsequent arrangements are a matter for private agreement between the parties concerned. The subjects which are dealt with cover both pure and applied branches and include, for example, physical measurements and testing, the design and supply of scientific instruments for special purposes and the control of processes by physical means. This arrangement will help the solution of problems faced at one place by the application of knowledge gained at another and will avoid a great deal of loss of time and patience of the workers. Recently there was some difficulty in the process of measuring the flow of certain animal secretions. A physicist in the ink industry was found out who made use of a method for measuring such a flow of certain printing inks having complex physical properties similar to the animal secretions. When the contact was made, the solution of the difficulty came very quickly. It is desirable that in this country also where we have just began to harness science to the aid of industries a number of registers should be compiled on such lines as above for technical assistance by the different learned societies of the country.

Meteorological Department's Report for 1939-40

THE administration Report for 1939-40, of the India Meteorological Department, states that the most important advance during the year was the improvement of weather forecasting facilities for airmen. The forecasting office at Delhi has been re-opened at the Willingdon Air Station, and is in close touch with aviation interests and is in a position effectively to meet their demand. Arrangements for removing the upper Air Office from Agra to Delhi are nearing completion. During the year, several new observa-

tories were started to meet the needs of the Air Force, the Civil Aviation Department and of shipping. New "current-weather" stations were started temporarily in north-west India and Kashmir with part-time observers, whose duty it is to supply current weather reports for Air Force flights in that area.

During the year a scientific expedition for investigation into cosmic rays from the United States of America, headed by Dr R. A. Millikan, Chairman of the Executive Council of California Institute of Technology at Pasadena, was assisted by the Department's officers, especially by the staff of the Agra Observatory. The expedition made observations at Agra, Gwalior, Peshawar and Bangalore by means of large balloons, to which were attached recording instruments. A report of the activities of this expedition was published in this journal on pp. 413-14 of the January, 1940, issue of the last volume.

A new wireless station, attached to the Meteorological office at Poona was opened on April 15, 1939. This station, and the New Delhi forecasting office, completed the Meteorological Department's "Regional Synoptic Scheme." The observations collected at Poona, Calcutta, Delhi and Karachi from selected stations in their own regions, are broadcast at specific times daily as "Regional Synoptic" messages. In addition, Poona acts as an All-India centre and broadcasts "collective synoptics" from which skeleton weather charts for the whole of India can be drawn. These regional and collective types of broadcasts have allowed India to reciprocate weather data regularly with countries as far afield as Egypt and Malaya, which broadcast their weather data in a similar fashion.

The Agricultural Meteorology Section continued to develop its liaison with the Agricultural Departments in the different provinces and States in India, while at the same time maintaining its record of investigation in many types of problems, all with the aim of elucidating the effect of weather and climate on crops. A start was made on an investigation to evaluate the effect of topography on local climate. The so-called "precision" observations, designed to reveal the effect of weather on various crops, have yielded, in particular, a unique set of data on the growth of rice during six different seasons. This section, which has been financed for seven years by the Imperial Council of Agricultural Research, has now been taken over by the Central Government as a charge on Central Revenues for a further period of three years, from April 1, 1940.

Last year nearly 6,000 warning messages were issued to ports and more than 1,800 messages to

shipping at sea, including those in connection with disturbed weather over the seas. Warning messages of heavy rain, untimely rain, high winds and frost numbered 8,900. The number of weather forecasts issued to aircraft from different forecasting centres totalled 11,533. Besides these, about 16,000 upper wind reports and 34,000 reports of current weather, including warnings of adverse weather and improvements thereof, were supplied to pilots from different stations along the air routes.

The study of the structure of some of the depressions and storms in the Indian area has revealed the necessity for a large number of simultaneous sounding balloon ascents in the field of a tropical storm before, during and after its passage over a particular area, in order to obtain more precise information about its structure process of formation and movement. To achieve this end, a scheme for a swarm of sounding balloon ascents ("swarm-ascents") during a post-monsoon storm in the Bay of Bengal has been drawn up.

Announcements

MR G. B. JAL, Science editor of the *New York American* has been recently elected president of the National Association of Science Writers of America. While working with the *New York Times*, he was awarded jointly Pulitzer prize for his meritorious reporting of the Tercentenary celebrations of Harvard University.

A GENERAL headquarters to co-ordinate and stimulate researches and discoveries of scientific workers in all spheres has been formed in Britain. The personnel will consist of internationally known scientific investigators like Sir William Bragg, Dr F. V. Appleton, Sir Edward Mellanby, Sir Edwin Butler, Professor A. V. Hill and Professor A. G. Egerton. The Chairman will be Lord Hankey who will convey the fruits of the new body's labours directly to the Lord Chancellor.

IN the United States also a National Defence Research Committee has been set up by the Council of National Defence to correlate and support scientific research with a view to improving the mechanisms and devices of warfare with the exception of those relating to aerial activities. The Committee will have the assistance of the National Academy of Sciences and National Research Council whose work will proceed independently. There will also be a close working relationship between the Committee and the newly created Inventors' Council. The Committee will take up those new ideas and inven-

tions which will be appraised by the Army and Navy in collaboration with this Council and arrange for further scientific research to complete their development and ensure utility. The chairman of the Committee is Mr Vannevar Bush, President, Carnegie Institution of Washington; and besides representatives of War and Navy Secretaries and the Commissioner of Patents the following are the members: Mr Richard C. Tolman, Dean of the Graduate School, California Institute of Technology; Dr Karl T. Compton, President, Massachusetts Institute of Technology; Mr James B. Conant, President, Harvard University; Mr Frank B. Jewett, President, National Academy of Sciences.

THE following gentlemen have been elected fellows of the National Institute of Sciences of India at the meeting of the Council held on 3rd October last:—

- Rai Bahadur Dr. K. N. Bagchi, B.Sc., M.B., D.T.M., F.I.C., Chemical Examiner to the Govt. of Bengal and Professor of Chemistry, Calcutta Medical College.
- Dr K. Ahmad Chowdhury, B.A., B.Sc., M.S. (Syracuse, U.S.A.), D.Sc. (Edin.), Wood Technologist, Forest Research Institute, Dehra Dun.
- Dr Mohammad Ishaq, M.Sc., Ph.D., Head of the Dept of Physics, Muslim University, Aligarh.
- Prof. K. B. Madhava, M.A., Professor of Mathematical Economics and Statistics, Mysore University.
- Dr D. N. Majumdar, M.A., Ph.D., F.R.A.I., Lecturer in Anthropology, Lucknow University.
- Dr D. Narayanamurti, M.Sc., Dr. Ing., A.I.C., F.Inst.P., Officer in charge, Wood Preservation Section, Forest Research Institute, Dehra Dun.
- Dr Vishwa Nath, M.Sc., Ph.D., F.R.M.S., Lecturer in Zoology, Government College, Lahore.
- Dr S. C. Roy, D.Sc., Director of the Burma Meteorological Service.
- Prof. S. K. Roy, Ph.D., Professor of Geology, Indian School of Mines, Dhanbad.
- Prof. N. A. Yajnik, M.A., D.Sc., A.I.C., Professor of Chemistry, Forman Christian College and Reader in Chemistry, Punjab University, Lahore.
- Sir Rickard Christophers, Kt., Bt-Col., C.I.E., O.B.E., F.R.S., I.M.S. (Retd.), has been elected a honorary fellow.

SCIENCE IN INDUSTRY

Size and Shape of Colloidal Carbon

COLLOIDAL carbon or carbon black is used for the reinforcement of rubber. With the aid of this toughening agent the life of the present tyres has been increased three times. Modern high-speed printing presses require inks which should produce clear instantaneous imprints and this is possible only by the use of colloidal carbon as their pigment. Protective films of black paints and lacquers owe their longer life to the reinforcing power of the colloidal carbon and its ability to screen out injurious actinic radiations.

The mechanism of this carbon reinforcement phenomenon was not properly understood and during the last 20 years many attempts have been made to explain it on the assumption of burr or feather-like surface structure. No convincing evidence could be available as the extreme fineness of subdivision so long defied optical resolution.

From photomicrographs taken with the two-stage electron microscope developed and perfected at the University of Toronto, the shape and size of ultimate carbon particles has recently been determined. Carbon black obtained from the luminous flames of natural gas was magnified to 102,000 diameters and was found to be spheroidal with non-serrated surfaces and having a mean diameter of 28 millimicrons (approximately 0.000001 inch). This is about one half the value previously accepted based on other methods of measurements.

Commercial carbon black consists of clusters or aggregates of these ultimate spheroidal particles. When used in inks, paints or rubber the clusters are dispersed to develop the maximum effectiveness of the carbon. Electro-photomicrographs of this dispersed carbon have revealed individual carbon particles ranging in diameter from less than 10 to about 60 millimicrons. From the above measurements and observations the reinforcement hypothesis based on serrated or reticular configurations has been abandoned, and instead a new conception of specific surface development has been advanced. The above researches may have far reaching influences on the

future developments of carbon black and its industrial uses.

N. K. S. G.

Manufacture of Drugs

CHLOROFORM, calcium lactate and carbolic acid have now been produced by Indian firms and samples have been received by the Medical Stores Department for tests. Samples of carbolic acid and cresylic acid, a disinfectant, have been found satisfactory. A sample of saponified cresol is being tested at the Central Research Institute, Kasauli. The chloroform has been produced by a Bengal firm and the sample is being tested for quality at the Biochemical Standardisation Laboratory, Calcutta, which is also testing a sample of calcium lactate. Samples of anaesthetic ether prepared by a Bengal firm have been tested by the Medical Stores Department and found satisfactory. This item has been in production for two years by the Department. An Indian firm is making five to ten tons of acetic acid glacial per month and is able to increase it to 30 tons a month without additional plant. It has unfortunately raw materials sufficient for one year.

Protective Films on Tin-plate

RECENTLY a new process has been developed by the International Tin Research and Development Council for protecting the tin-plate in tin cans from the action of sulphur in preserved foods. The usual method up till now was to coat the interior of the container with a special sulphur resisting lacquer, but this operation is expensive when compared with the new process and in some cases the lacquer has been found to react unfavourably on the flavour of the food product. It is stated that the new protecting film is an oxide and it is so thin that it is invisible. The film protects the underlying tin from the actions of sulphur compounds, produced by a slight decomposition of the proteins contained in certain types of vegetables, meat and fish products as a result of the sterilisation process. This decomposition of the proteins may cause blue or black stains to appear on an

unprotected tin-plate surface, and this discolouration is not only bad to look at, but may, in extreme cases, affect the appearance of the contents. Moreover in the case of some vegetables the colour is affected, green being changed to an unpleasing yellow.

In the Council's Laboratories the oxide film was first produced on the tin by immersing the plated articles in a hot solution of chromic acid for 15 minutes. But it had some disadvantages as a film of palm oil was left on the tin plate from the hot-tinning operation. The process has been now modified by taking a hot alkaline solution containing sodium phosphate and a chromate. The alkaline bath produces the required oxide film and simultaneously removes the oil film. The time required for dipping is two minutes only. The film has been tested with various types of preserved foods. Tests with meats and fishes are promising. But tests with various kinds of fruits, however, have given poor results, as the film appears to be slowly dissolved by the citric acid present.

N. K. S. G.

Non-Tin Container for Food

A NEW type of container for packing food products has been developed in Germany, which dispenses altogether with the use of tin plate, according to a report from the American Consulate General at Frankfort-on-Main. Instead of tin for coating the iron, the base sheet for making the new type of cans is coated with a phosphate film by the Bonder phosphate rustproofing process. A thin, tight, and uniform phosphate film is placed upon the iron sheet in 2 or 3 minutes by immersion in a special phosphate bath. The entire production process requires 30 minutes. There is another novelty in the cans. Instead of being soldered, the can is welded, enabling a further saving of 2 per cent in can material. Special automatic machines have been developed for efficient welding.

N. K. S. G.

New Synthetic Rubber Manufactured by Goodrich

GOODRICH Rubber Co. of U. S. A. is now manufacturing tyres in which 50 to 100 per cent of natural rubber has been replaced by synthetic product, "Ameripol". The name Ameripol signifies a polymer made from American materials. From reports so far available it is known that the basic material is American petroleum from which butadiene is separated. This is mixed with other ingredients prepared from natural gas and air and then made into

a milky emulsion using soap produced from agricultural sources. Upon heating and agitation, these ingredients react to form an emulsion of synthetic rubber, which is similar to the latex from rubber producing trees. With this synthetic rubber, the process of manufacture is like that of natural rubber. A semi-commercial plant is already in operation and Goodrich is constructing a plant which will produce several tons of Ameripol daily.

N. K. S. G.

Industrial Reorganisation of Bombay

THE report of the Bombay Economic and Industrial Survey Committee which has just been published observes that the government have as yet spent very little on the problems of marketing, finance and research. The other government departments concerned with economic activity have not also had a well-formulated and vigorous programme of economic development, and they lack in industrial bias. There has been very little co-ordination between these different departments and there is no provision for periodic consultations with a view to industrial development among the heads of these "economic" agencies of the government, viz., the Director of Agriculture, the Director of Industries, the Registrar of Co-operative Societies, the Chief Conservator of Forests, the Superintendent of Government Stationery and Printing Press and the Chief Engineer.

The Committee stresses the potentialities of semi-agricultural industries like poultry-keeping, bee-keeping and sericulture. There are, says the report, possibilities for establishing the aluminium industry in this province as bauxite deposits have been discovered at Tungar Hill near Thana; and a high class earthenware industry as clay suitable for high class potteries is stated to be available locally. Bakelite, electrical goods, raw films, radio sets, bicycles and automobiles are other commodities which offer scope for domestic manufacture. Fruit canning and the manufacture of other fruit products has great possibilities. Fibre resources should be more economically utilised. A good deal of agricultural produce which is being wasted at present could give rise to new industries. Forest products offer enormous scope for building up new industries. The fisheries resources can also be exploited on a very profitable scale. As a part of a policy for the economic betterment of the province, the Committee suggests that a programme of rapid road construction may be immediately undertaken and the new transport facilities will offer scope for rapid growth of trade and industry.

"It must be borne in mind", says the report, "that the structure, the composition and the pace of industrial development are very greatly dependent upon tariffs, transport and currency, none of which vital determinants of economic development are under the control of the provincial government; and without controlling these, it is difficult to carry out any industrial policy meant to result in speedy industrial development. Moreover, the implications of provincial action in the industrial sphere may extend far beyond the provincial boundaries and that, therefore, the reactions on the other provinces and the Indian States have to be constantly taken into account.

With regards to the question of the relation of large-scale and cottage industries, the Committee feels that there is a large non-competing field between the two as also scope for co-operation. The Committee suggests that the question of regulating their relations should be discussed at a special conference of the representatives of the provinces and the Central Government. Discussing the relation between small-scale and cottage industries, the Committee is of opinion that no regulation is necessary here except in the case of the textile industry where the growth of small power-loom factories needs to be restrained. Even here no action should be taken without obtaining the approval of the other Governments in India, as these units may be serving the economic interests of other provinces.

The difficulties of the cottage industrial workers are primarily in the field of marketing, and to meet this difficulty the Committee recommends that each district should have an industrial association in charge of a district industrial officer assisted by a

local advisory committee. The district industrial association should supply raw materials to artisans and sell their products, give them improved tools on the hire-purchase system and organise demonstrations, etc. Membership of the association should be open to all whole-time cottage workers resident in the district. The industrial association should have attached to it a small museum displaying the raw materials of the district, the finished products that can be made from these raw materials, the industrial requirements of the district and the possible industrial substitutes for the non-district industrial goods now in use. It should also organise district industrial exhibitions every year. For financing the cottage worker, a special organisation should be set up which should not deal direct with the cottage workers but only with the industrial associations. In the alternative, the Government may place Rs. 25 lakhs at the disposal of the cottage industries section of the Industries Department.

The Committee recommends that there should be authoritative collection and compilation of commercial and industrial information, which should be made the special work of an officer attached to the Industries Department. He should also publish an industrial bulletin containing abstracts of important trade articles and items of research interest in the Government's laboratories.

For the formulation of a positive industrial policy, the creation of a Board of Economic Development is suggested, and this Board should draw up a time-table of industrialisation based on the details collected by an industrial census. The reorganisation of the Industries Department on the lines proposed in the report is estimated to cost approximately Rs. 25 lakhs.

Automobile Factory in Bombay*

THE question of the establishment of an automobile factory in Bombay was first mooted in the year 1934. The first step taken in this matter, after the Bombay meeting in April 1935, was to send Sir M. Visvesvaraya to visit foreign factories where the industry flourished in full vigour, to consult there recognised experts, and frame and submit a report to the promoters. In April 1936, a printed report embodying the results of the foreign tour and investigations was placed in the hands of all those business men in Bombay who had previously attended meetings or taken an interest in the project. Copies were also submitted to the authorities of both the Government of India and the Government of Bombay. In this journal on the basis of

Sir M. Visvesvaraya's report were published two articles under the headings, 'The Automobile Industry in India' (Vol. 4. p. 258, 1938-39), and 'Manufacture of Motor Vehicles in India' (*loc. cit.* p. 401) and also a short note on page 512 of the same fourth volume referring to later developments. We would refer our readers to these pages, which will be of interest in the present connection.

By the time the report was ready, a wave of pessimism, due, it is believed, to adverse propaganda,

* Adapted from a note by Sir M. Visvesvaraya circulated with the purpose of answering enquiries which are frequently received about this project, and of explaining what progress has been made so far, and what further action or facilities are needed for an early start.

caught some of the influential Bombay friends who had originally encouraged the scheme. It must be remembered in this connection that since foreign interests are likely to be affected by the establishment of the proposed industry, some degree of hostility to the scheme is expected. Even to-day there is a tendency on the part of a minority in the trade to spread the misleading view that it is "better to buy than to build" motor vehicles in India.

INDIA GOVERNMENT'S ATTITUDE

However, sufficient public support being assured, representations were submitted both to the Government of India and the Government of Bombay for co-operation and help. The first representation to the heads of both these Governments was made on 7th May, 1936. The Government of India while expressing sympathy with the project stated that they adhered to the policy of discriminating protection for Indian industries enunciated by the Fiscal Commission of 1921-22 and could not go to the help of an industry that was not started. Neither could they commit themselves beforehand, that is, before a factory was actually in operation, to purchase any of the products ordinarily required for Government use. However, in view of the service which an automobile factory is likely to render for defence purposes, the Government of India have now been obliged to mobilise even the meagre assembly equipment in India of two American motor car companies.

A press message from Simla reported some time back that the two motor companies, General Motors and Ford, which possessed large assemblage and body building plants in India were co-operating with the Government in the production of vehicles for the Indian Army. Although it was not possible to state the numbers or types which were in production at these plants, it could be said that the present initial expansion of the Indian Forces involved an increase of between twenty and thirty thousand in the number of vehicles required by the Army. All these were divided into no less than 56 types. To assist in coping with these requirements, the American concerns had recently considerably extended certain sections of their works and these extensions would be specially devoted to urgent Government work. This message shows the quantity of large orders placed with the two prominent American automobile companies. A request for such orders was made to the Government of India four years ago but there was no response. No reason, save their adherence to the old policy of discriminating protection, was given for denying similar facilities to an indigenous enterprise.

PROGRESS OF THE PLAN

The Bombay Government, on the other hand, wanted, subject to certain conditions, a guarantee of 3 or 3½ per cent. interest on a capital issue of Rs. 150 lakhs for the industry for a period of ten years. Before the concession was finally sanctioned, the Congress Government went out of office; and the present Government of Bombay are yet to ratify the promise made by their predecessors. In the concession just referred to, one of the conditions was that the new factory should be run by a firm of Managing Agents, and as soon as the provisional promise of a concession by Government to guarantee 3 or 3½ per cent. interest on share capital for a term of ten years was received, Mr Walchand Hirachand of Bombay, one of the promoters who had warmly supported the proposal from the commencement, offered to start a firm of Managing Agents with himself and two other well-known industrialists, Mr Dharamsey Mulraj Khatau and Mr Tulsidar Kilachand, as partners.

Mr Walchand Hirachand lost no time in taking the next move. He obtained from the Government of Bombay the loan of the services of Mr P. B. Advani, Director of Industries, Bombay, for the purpose of arranging terms and entering into an agreement with one of the automobile firms of repute in England or America, and obtaining its active co-operation for starting the proposed factory in Bombay. Mr Advani, in close consultation with Mr Walchand, first discussed the proposals with the Ford Motor Company of Dearborn, U.S.A., and next with the Ford Motor Company of Canada. India came within the operations of the Canadian Ford Motor Company so far as supply of Ford motor vehicles was concerned, but that Company was not willing to co-operate with the promoters unless it was allowed to participate substantially in the capital of the Company by owning 51 per cent of it. The promoters expressed inability to agree to this, and as a result the negotiations with the Ford organisation had to be reluctantly abandoned.

Mr P. B. Advani next started negotiations with another large firm, the Chrysler Corporation of Detroit (U.S.A.) with which a definite agreement has been concluded for manufacturing their motor vehicles in India on a royalty basis, that is, without participation of American capital in the Indian Company. The promoters are also in correspondence with a leading British Motor Car Company for manufacturing in India, on a royalty basis, their low power cars. The British Company concerned has promised cordial co-operation, and negotiations are proceeding satisfactorily.

Both the manufacture of medium power vehicles under license of the Chrysler Corporation and of

low-power cars under license of the British Company referred to could be undertaken if Government help is available at least for the first few years.

PROSPECTS OF THE INDUSTRY

Sir M. Visvesvaraya's original report was issued in 1936, there has since been an appreciable change in the public demand in India from medium power to economical low-power cars. When the scheme in its present form as outlined by Mr Advani is completed and brought into operation, the number of vehicles manufactured yearly is expected to be 11,000 instead of 12,000 and the total capital outlay required for the factory will be the same as in the original scheme, namely, Rs. 2¼ crores. But the same machinery and plant will, with small additions, be able to manufacture even upto 20,000 units whenever demand arises for so many.

The value of the products manufactured yearly at recent normal rates will probably be as under :—

	Rs. lakhs
3,000 medium power cars at Rs. 3,500	105
5,000 trucks at Rs. 3,000	150
3,000 low-power cars at Rs. 2,000	60
Total	Rs. 315 lakhs.

This will be the approximate yearly value of motor vehicles which a factory constructed at a cost of Rs. 2¼ crores in this country would be able to manufacture at the outset.

Authoritative statements have been prepared and published in the United States of America which show that the price of a motor car to the consumer in a foreign country like India is about 2½ times the actual cost, *ex works* in America. A car which costs, say Rs. 1,400 in a factory in Detroit would be sold for about Rs. 3,500 in Bombay. The difference of Rs. 2,100 is at present spent on inland freight in America, ocean freight, sea insurance, loading and unloading charges in Bombay, import duty, dealer's commission and a few other minor items. The bulk of these charges will be saved if vehicles are made in India.

In the case of a car manufactured in India, the only heavy expenditure to be incurred outside the factory would be the import duty on special parts if no concession is secured from Government and the dealer's commission or profit. A liberal estimate of outlay on these two items will probably be Rs. 750. Taking the price prevailing in normal times, the saving per car would be Rs. 2,100—Rs. 750=Rs. 1,350. Assuming that the working of the Indian factory will not be as economical as in America and saving not as high as Rs. 1,350

but only Rs. 500 per unit, or one-seventh of the normal price of a completed car, the total clear profit would be one-seventh of the sum of Rs. 315 lakhs or Rs. 45 lakhs. This will mean, under favourable conditions, a profit of 20 per cent. on the initial capital outlay. The profit will vary with changing market conditions but the rough calculations here given should leave no doubt in the mind of the reader that the prospects of the industry are very promising.

MANUFACTURE SIMPLIFIED BY AUTOMATIC MACHINERY

A good many people, even among industrialists, are obsessed by the fear that the manufacture of motor vehicles is a very complicated and difficult matter and the Indian workman is not yet trained for this delicate work. But such fears are groundless. The machinery used in the manufacture of parts is to a considerable extent standardised and its action is largely automatic. The thought and skill required in manufacture has been transferred from the workman to the machine and "although the motor vehicle is a most delicate and finely adjusted machine, the human labour and human intervention utilised in its manufacture is reduced to a minimum." The experience of automobile assembly plants of which there are a number working in India shows that the Indian workman is quite capable of handling this class of machinery and of producing articles of the required quality, strength and finish.

MOTOR VEHICLES MANUFACTURED IN THE PRINCIPAL COUNTRIES OF THE WORLD

The manufacture or production of motor vehicles in the leading countries in the years 1938 or 1939 was as under :—

Country.	Year.	Motor Vehicles produced.
United States	1939	3,577,058
Canada	1939	155,316
Great Britain	1938	477,561
France	1938	220,343
Germany	1938	328,000
Italy	1938	70,388
Russia (U.S.S.R.)	1938	215,000
Japan	1938	30,000
India	.....	Nil.

The maximum yearly production in some of the countries is much higher. In the United States of America, for instance, the vehicles manufactured in 1929 was 5,359,090. The above information, which shows the production to be much in excess of that in the past years, should dispel any doubt about the Indian factory reaching its saturation point within a few years of the start.

Mainly for export purposes, several leading manufacturers in America have established branch factories in Canada. For instance, the Ford Manufacturing Company of Detroit, U. S. A., has an associated factory in Windsor (Canada), and this Canadian factory supplies Ford vehicles of the type manufactured in Detroit to all parts of the British Empire. The Canadian Ford Company has the exclusive right to supply such cars to India. But Ford cars including the low-power ones manufactured at Dagenham, England, come direct to this country from England.

SUPPORT GIVEN TO THE INDUSTRY IN FOREIGN COUNTRIES

Before the War there were over 40 factories in France, manufacturing automobiles or their parts, and which were maintained in slack times by orders for armaments and defence machinery given by the French Government. Without such support the factories could not have possibly existed.

Germany being unable to compete with America put up a prohibitive duty. Herr Hitler encouraged the industry in several ways, one of which was to exempt people who purchased German-made cars from paying certain taxes for a term of years. As a result of this encouragement and other facilities given, the industry which produced only 52,000 vehicles in 1932, increased production to 243,000 in 1935, and to 328,000 in 1938.

Russia started the manufacture of motor vehicles some eight years ago. The Soviet Government opened an office in New York and stationed a number of Russian engineers there to export machinery and parts for manufacture in Russia. This, they did, in close co-operation with the Ford Motor Company of Dearborn, U.S.A. In the first year, they took all the parts to Russia and assembled them and completed the car. In this way they made 5,000 cars. In the second year, they purchased 50 per cent. of the parts and made 10,000 cars. In the third year, 25 per cent. of the parts were purchased and 20,000 cars were made; and in the fourth year, they manufactured 40,000 cars. As a result of the activities of her Government, Russia which manu-

factured only about 40,000 vehicles in 1935, increased production to 215,000 vehicles by 1938.

NOTABLE ENCOURAGEMENT IN AUSTRALIA

The support promised under similar circumstances by the Commonwealth Government of Australia to a local Company, *before it proceeded to make the necessary arrangements to establish the industry in Australia*, is the latest and the most significant instance of the helpful attitude of modern Governments towards this industry.

On December 19th, 1939, the Commonwealth Government entered into an agreement with a local Company, the Australian Consolidated Industries, Ltd. The agreement stated that a Motor Vehicle Engine Bounty Act had been passed in the Australian Parliament which provided for the payment of a bounty of £1,500,000 for the first 60,000 motor vehicle engines manufactured by the Company.

Some of the other principal provisions in the agreement are:—

- (a) Two-thirds of the paid-up value of shares should be owned by subjects resident in Australia.
- (b) The Commonwealth Government will safeguard the interests of the Australian Company against the establishment of rival manufacturing foreign Companies.
- (c) Government will use its power of import control to counteract any foreign trading methods by overseas interests in selling competitive vehicles in Australia.
- (d) For five years from commencement of manufacture, the Commonwealth Government will purchase a substantial portion of its requirements from the proposed Factory.
- (e) Government will admit free of import duty such machinery as cannot be conveniently manufactured at the outset within a reasonable time.
- (f) The Commonwealth Government will be prepared to examine upon request the measure of tariff or other assistance needed for import of any special automobile parts.

HELP EXPECTED FROM OUR GOVERNMENT

The support expected from the Government of Bombay is the confirmation of the guarantee of 3½ per cent. interest on capital outlay, provisionally promised by the Premier of the previous Congress

Government. This support will be in conformity with the declared policy of the Government of Bombay to grant assistance, specially to new and nascent industries.

The support expected from the Government of India according to the latest appeal is reduced to three items:—

- (1) The factory may be treated as a War measure since it will be able to manufacture and supply Army trucks, armoured cars, and if necessary also armaments. At a few weeks' notice the factory equipment can be transformed into an armament plant; and, with small additions to the plant, the factory will be sufficiently equipped to manufacture aeroplane engines when required. In view of this prospect, the grant of dollar exchange and import permits for purchases made for the projected factory should take precedence over civil requirements for other purposes.
- (2) It is understood, that the Government of India have a programme to purchase annually 5,000 new motor trucks for the mechanisation of the army. It would not be out of place for Government to promise a substantial part of this order to the projected local factory since its arrangements with the Chrysler Corporation of Detroit, as explained before, ensure that vehicles of the highest quality obtainable anywhere in the world can be supplied.
- (3) Reasonable tariff concessions may be granted in connection with imports of parts and raw materials required for the local manufacture of motor vehicles, to the extent commonly done in European countries and in Canada.

IMPORTANCE OF THE INDUSTRY

The projected Indian factory will from the very commencement be a manufacturing concern and not a mere assembly plant. Since the outbreak of the

War, prices of motor vehicles have risen, and high prices will continue to rule for two or three years after the War. If the factory is started now, it will not only be providing trucks for War purposes and for the Indian Army within some eight months, but it will also be profiting itself and materially benefiting the country as a War time industry.

As explained before, there has been some amount of propaganda carried on, apparently by interested parties, to mislead the public that the industry is not wanted here. While small States like Belgium, Australia and Norway with populations numbering 8, 7 and 3 millions, respectively, are establishing motor car factories, it cannot be said that one such factory will be a superfluity in this sub-continent of ours with its 375 million population.

Two of the largest automobile Corporations in the world have after investigation concurred in the size, scope and estimated cost of the Bombay project as outlined in 1936. We have seen that a leading American Company was willing to put some of its own money into the concern if allowed. Another leading Corporation has actually entered into a working arrangement with the promoters of the Indian project for manufacturing their motor vehicles in Bombay on a royalty basis. The former would not have offered to participate in the capital of the scheme; nor the latter entered into an agreement, unless the prospects of the industry were distinctly bright.

It is evident from this, that the proposals which have been before the business public for the past five years, and before the Central Government and the Government of Bombay for at least four years, are sound from every point of view. Had the industry been started when the project was first mooted in the year 1936, it would have been in successful operation by now, and of special value for War purposes in the present emergency.

With the starting of the factory, a number of subsidiary industries would be springing up and thousands of people will get employment. Local industries of this importance have a legitimate claim on the revenues of the country and on active Government encouragement and support. To neglect the industry under present world conditions would be a discouragement to economic enterprise, a hindrance to progress, and a danger to the country's safety.

Production of Clean Milk in an Indian Household

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THE production of milk in the West has now become a scientific art whereby milk is produced under controlled conditions and graded according to definite bacteriological standards before it is put in the market. More recent advancements have brought forth such specialized products as Irradiated milk, Vitamin 'D' milk and the Acidophilus milk.

Compared with this, the art of milk production in India remains as primitive as ever. Co-operative dairying is practically unknown and the few dairies that are working in India are mostly patronized by the European or high class Indian gentry. In rural areas farmers mostly produce their own milk supply while in towns and cities the milk supply is mainly controlled by *gowalas* who are addicted to innumerable malpractices.

Most of our producers do not realize the importance of hygienic precautions in milk production and the educated few, who do, often consider them unnecessary since milk in India is mostly consumed after boiling or simmering. The argument is, however, faulty firstly because during the hot weather when conditions for the growth of bacteria are the most favourable, milk is often consumed raw and secondly because our experiments, reported elsewhere (1940) have shown that simmered milk when exposed to contaminants is more suitable for the growth of bacteria than even the raw milk.

About 89% of the total population in India lives in villages where milch cattle are kept under most insanitary conditions; the cattle yards are littered with dung and manure, and no precautions whatever are taken in milking. Conditions in towns and cities are still worse. The milch cattle are kept in dingy closed rooms or in narrow lanes over the sewage drains. The hygienic value of milk produced under such conditions cannot but be questionable.

Milk is a complete food not only for children and adults but also for bacteria. Special attempts have therefore to be made to prevent its becoming a source of disease.

The value of cleanliness in milk production is fully illustrated by the advance made in other countries but very little direct work has been done on the subject in India, mainly because our scientific workers have taken for granted what holds good in the West. This we think is not the right attitude because our climatic, economic and social conditions are entirely different from those of the West. A study of the various factors as affecting milk production under our conditions, therefore, seems very desirable.

With this object in view a series of experiments was conducted at Lyallpur to determine the worth of some simple precautions regarding the production of milk. In making these trials the fact that our farmers and city milk producers are generally poor and illiterate and that they have to be convinced by some simple yet direct and inexpensive means before they can be persuaded to adopt improved practices, has all along been kept in view.

EXPERIMENTAL DETAILS

Cows of identical breed at nearly the same stage of lactation were selected for the experiments. A preliminary examination of milk was made in each case to spot out any abnormality in the animal.

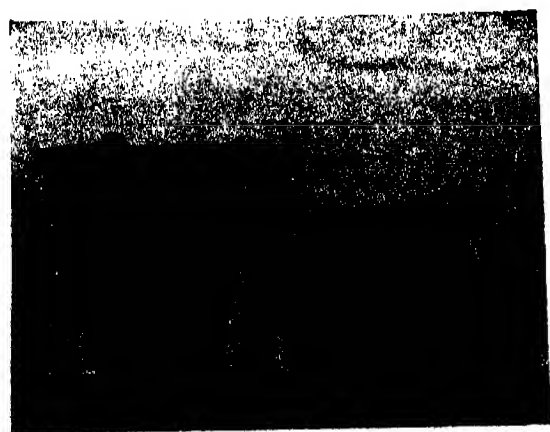
The trials were at first conducted in the college dairy and subsequently repeated in a *gowala's* house so as to make the conditions more nearly identical with those of an average household. Since calf-suckling is usually practised, all the precautionary treatments in a *gowala's* house, were carried out after this operation was over.

The effect of the following procedures on the quality of milk produced was studied:—

- I. Unsterilized pail, tail untied, foremilk not removed.
- II. Sterilized pail, tail tied, foremilk removed.

- III. Sterilized pail, tail tied, foremilk removed, udder and hands washed with water.
- IV. Sterilized pail, tail tied, foremilk removed, udder and hands washed with potassium permanganate solution (1:2000).
- V. Pail cleaned with mud, tail tied, foremilk removed, udder and hands washed with potassium permanganate.
- VI. Pail cleaned with ash, tail tied, foremilk removed, udder and hands washed with potassium permanganate (1:2000).
- VII. Pail cleaned with ash and kept in the sun (8 hours, maximum temperature 130°F) tail tied, foremilk removed, udder and hands washed with potassium permanganate (1:2000).
- *VIII. Pail cleaned with ash and kept in shade, tail tied, foremilk removed, udder and hands washed with potassium permanganate (1:2000).

The standards used to judge the effectiveness of such precautions were: (i) the number of bacteria present in a millilitre of milk by the plate method, and (ii) the reduction time as indicated by the methylene-blue reductase test. For purposes of comparison trials were made with two different types of pail that are most commonly used in the Punjab (Fig. 1).



Balli
(Galvanized iron)

Dohnd
(Brass ware)

Fig. 1. Showing different types of pail used in the Experiments.

For counts of the numbers of bacteria, platings were done on skim milk agar of the following composition:

Skim milk	...	...	2%
Bacto peptone	...	...	0.5%
Beef extract	...	...	0.1%
Glucose	...	...	0.1%
Agar	...	...	1.5%

The reductase test was carried out according to a recent modification by Thornton (1937) whereby milk tubes containing the standard methylene-blue solution are shaken every half an hour. In order to determine the comparative worth of different treatments several repetitions were made in each case but results of only typical observations are presented here.

RESULTS

Tables I-VI being sufficiently explanatory only a brief account of the experimental results is given below:

Results given in table I indicate that milk produced without precautions gives the highest

TABLE I

Showing the effect of different precautions on bacterial numbers and keeping quality of milk

Treatments	College dairy samples.		Gowala samples.	
	Bact. per c.c.	Reduction time.*	Bact. per c.c.	Reduction time.
1. Unsterilized pail, tail untied, foremilk not removed.	10150	7 hrs.	19100	6 hrs.
2. Sterilized pail, tail tied, foremilk removed.	1450	12 "	3150	8 "
3. Sterilized pail, tail tied, foremilk removed, udder and hands washed with water	530	15 "	1250	10 "
4. Sterilized pail, tail tied, foremilk removed, udder and hands washed with KMnO_4 .	110	more than 18 hrs.	700	more than 15 hrs.

* This treatment is essentially similar to treatment VI but a separate trial on these lines had to be conducted side by side with treatment VII for comparative purposes.

* The quality of milk produced in all cases was fairly good because real bad milk reduces the colour of methylene-blue within 2 hours.

bacterial counts, while the numbers are very much reduced when the pail is sterilized, foremilk is discarded and the tail is tied. Still better results are obtained if, in addition, the milker's hands and the cow's udder are washed with potassium permanganate solution. Within the scope of these trials treatment 4, gives the best quality of milk.

Marked differences in bacterial numbers and the reduction time of methylene-blue are found when the pails are either cleaned with mud or cowdung ash (Table II). Ash with its relatively low bacterial content and better germicidal property is found to be a much better material for cleaning the pails.

TABLE II

Showing the effect of cleaning milk pails with mud or ash on bacterial numbers in milk.

Treatments	College dairy samples,		Gowala samples,	
	Bact. per c.c.	Reduction time.	Bact. per c.c.	Reduction time.
1. <i>Balti</i> cleaned with mud	2600	10 hrs.	4800	8 hrs.
2. <i>Dohna</i> cleaned with mud	8400	8 "	6500	8 "
3. <i>Balti</i> cleaned with ash	1300	14 "	2200	7 "
4. <i>Dohna</i> cleaned with ash	1500	14 "	2300	7 "

N.B.—To prevent interference from other causes a few drops of pure milk were removed and the udder and hands washed with KMnO_4 (1:200), in every case.

If the pails after cleaning with ash are kept inverted in the sun for a few hours the number of bacteria is very much reduced, viz., 3-6 per ml., practically approaching the sterilized pails (Table III). Milk drawn in such pails with proper

TABLE III

Showing relative bacterial counts in pails cleaned with ash and kept in the sun and in shade.

Treatments	Bacteria per c.c.	
	College dairy samples,	Gowala samples,
1. <i>Balti</i> kept in sun ...	6	18
2. <i>Dohna</i> kept in sun ...	3	8
3. <i>Balti</i> kept in shade ...	120	230
4. <i>Dohna</i> kept in shade ...	180	380

N.B.—200 c.c. of sterilized water were used for rinsing each pail.

precautions (cf. Treatment No. VII) also shows much lower counts of bacteria (Table IV).

TABLE IV

Showing the effect of pails cleaned with ash and kept in the sun (8 hours, maximum temperature 130°F) and in shade, on bacterial counts in milk.

Treatments	College dairy samples,		Gowala samples,	
	Bact. per c.c.	Reduction time.	Bact. per c.c.	Reduction time.
1. <i>Balti</i> kept in sun	70	14 hrs. over	840	9 hrs.
2. <i>Dohna</i> kept in sun	75	18 hrs.	760	9 "
3. <i>Balti</i> kept in shade	5100	10-12 hrs.	2200	7 "
4. <i>Dohna</i> kept in shade	6000	10-12 "	2300	7 "

N.B.—To prevent interference from other causes, a few drops of foremilk were discarded and the udder and hands washed with KMnO_4 (1:2000), in every case.

Bacterial counts in *gowala's* samples are relatively higher than those in the dairy milk, apparently due to differences in the sanitary conditions of the two places. The general trend of results is however much the same in both the cases.

In order to determine the degree of effectiveness of such treatments the essential data were subjected to a critical statistical test and the analysis of variance worked out as shown in table V.

TABLE V

Analysis of Variance

Due to.	Degree of freedom.	Sum of squares.	Mean square.	Ratio of variance.
Replications ...	5	2128.6	425.720	...
Treatments ...	6	155401.2	25915.200	97.08
Error ...	30	8007.8	266.926	...
Total ...	41	166627.6	...	...

It is observed that the results are highly significant even at one per cent level. This would indicate that the differences are not mere chance variations but are actual expressions of the precautions taken. Furthermore to evaluate the relative significance of different treatments, critical difference has been calculated and the bacterial counts (actual numbers per c.c. have been divided by 100, to simplify

the calculations) arranged in the order of the effects produced (cf. Table VI).

It is evident that treatments I, V and II are highly unhygienic. While a marked variation is apparent in the bacterial counts of milk under treatments IV, VII, III and VI, the differences are insignificant statistically.

TABLE VI

Treatments arranged in order of the effects produced.
Critical difference=19.2.

Treatments.	IV	VII	III	VI	II	V	I
Bacterial Nos. per c.c./100	7	8	12.5	23	31.5	65	191

Economic depression together with ignorance of precise precautions has greatly impeded the hygienic production of milk in this country. Since elaborate devices for steaming and disinfection as advocated

by foreign workers are not practicable in India, such simple and cheap precautions as the washing of milker's hands and the cow's udder with clean water or potassium permanganate solution discarding a few drops of the foremilk and cleaning the pails with ash and exposing these to the sun, etc., should prove very helpful in the production of clean milk. Since *gowala's* house depicted more closely the conditions of an Indian house-hold, statistical analysis has only been restricted to this set of experiments.

In fact these simple trials were conducted more for the purpose of providing figures that would appeal to an absolute novice than for scientific interest. On the basis of the experimental results it is claimed that if our *gowalas* and farmers could be persuaded to adopt these simple precautions, the production of high quality milk is possible in everyday practice even under our conditions of extremes of climate and of social and economic backwardness.

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- ¹ *Proceedings*, (1940) Ind. Sc. Cong., 1940.
- ² Thornton, H. R. (1937), *Jour. Dairy Sci.*, 20, 693.

FORCING WATER INTO HUMAN BODY

A jet of water under pressure of 15,000 pounds per square inch, issuing from a tiny hole, may become part of cancer treatment in the future. This method of painlessly forcing water through the skin instead of using a hypodermic needle injection was reported by Drs G. Failla and T. R. Folsom.

Cancer yields more readily to X-ray treatment when distilled water has been injected to drown the cancer, as it were, after X-ray bombardment.

The idea of using a very fine, high-pressure jet of water came from reports of the injuries suffered by workers with high-pressure oils. The injuries were at a considerable depth from the surface of the body. The oil, emerging in a fine stream from a tiny hole, penetrated the body without the worker being aware of it. The method may be used, Dr Failla suggested, not only for getting distilled water into tumors in conjunction with X-ray treatment but also for injecting radioactive substances into the tissues.

The water jets penetrate the skin an inch or more, preliminary tests have shown. Skin offers considerable resistance to the jet as compared with other substances. The jet can penetrate raw potatoes, for example, to a depth of three or more inches.

Although the water jet can be used to introduce liquids into human tissues, Dr Failla says no "distinct superiority of the jet over the needle method" has appeared.

MEDICINE & PUBLIC HEALTH

Some Economic Features of Japanese Food

JAPANESE diet plays an important part in the economics of the people. The Japanese obtain the three essential constituents of food, namely, protein, carbohydrate and fat, from a dietary quite different from what is a rule in Europe or America. The sources and proportions, for instance, of protein as taken by the Japanese people may be seen from the table below, in comparison with those of the same substance as obtained by the Europeans from their daily dietary. The figures in the table are constructed with the normal human requirement of protein as 100.

JAPANESE.		EUROPEANS.	
Cereals and potatoes	44.9	Cereals and potatoes	42.3
Fish	18.5	Meat	22.1
Beans	18.3	Milk & dairy products	19.0
Others	18.3	Others	16.6
Total	100.0	Total	100.0

From the above, it will be seen that while the Europeans obtain protein chiefly from meat, milk, butter and cheese, the Japanese find the same food essential in fish and beans, protein in the latter's case being represented by soya beans in a predominant proportion.

In order to obtain a given amount of meat, milk and other dairy products one must give to the animals seven times as much quantity of protein of vegetable origin. The growing of livestock feed, therefore, is an important part of agricultural work in most European countries. One half and, sometimes even two-thirds, of the tillable acreage is placed under fodder and crops for animals. But fish and beans on which the Japanese people mainly depend for supply of one of the essential constituents of diet are grown by nature. Fish grow up in the sea. The soya beans happen to be one of the species which require no nitrogenous manure. The bacteria in their roots absorb nitrogen to produce one of the richest vegetable foods. As for fat the Japanese obtain it chiefly from vegetable articles of diet, and the amount taken is much beyond the biological requirements. The Europeans seek fat in foods of animal origin, and the amount they take generally

far exceeds the amount really required for physical purposes. Living under one and the same price level, the Japanese spend 60 per cent less on their daily diet than the Europeans.

Operation in Blood Bath

A CAREFUL surgeon would no more neglect to drain off escaped blood while operating in the peritoneal cavity than he would operate with unsterilized instruments. Careful drainage helps to keep the cavity clean, and lessens risk of peritonitis, though instances are available of its developing after "dry" operations. A modification in this practice of surgery has been suggested as a result of manipulating a rush of patients for such an operation. During the Arab-Jewish riots of 1936 in Jerusalem, Dr Edward G. Joseph of Hadassah Hospital had many patients whose abdomens were badly shot up. Dr Joseph had not enough time to resort to drainage, and he operated in a blood bath, stitched up his patients' intestines, closed their abdomens without further ado. The victims recovered with no hint of peritonitis and the success suggested that free outpouring of blood in the peritoneal cavity might be of help rather than harmful. Dr Joseph has tried out his theory on dogs and rabbits, then further on humans. When he soiled the peritoneum without allowing bleeding, during an operation on the colon, eleven out of twelve animals developed peritonitis. When fresh blood was injected into the cavity, only one in four became infected and adhesions were notably few. On human patients 200 c.c. of blood run through a tube into the abdominal cavity at the end of the operation produced favourable recoveries. These findings are summarised in the July issue of *Lancet*.

Home Treatment for Syphilis

WITH the progress of medical research the chemical means to cure syphilis are available now but for its real conquest there is the problem of lining up the patients. Standard syphilis-destroyer is arsphenamine, the drug salvarsan ("606"), which Germany's Paul Ehrlich prepared 30 years ago.

Mercury and bismuth compounds are also useful. But all these drugs must be injected regularly over a long period (18 months to 2 years) and many patients dislike injections and monotonous visits to the doctor. When their gross symptoms disappear, they often abandon treatment forthwith, still harbouring the pale lurking spirochetes. A sensational new drip treatment which enables patients to assimilate massive doses of arsenicals a drop at a time through their veins provides a quick cure of early syphilis in some cases. An account of this was published on p. 47 of the July, 1940 issue of this journal. But in this method a patient must co-operate by staying in a hospital for five days.

Doctors have long wanted a syphilis antidote which can be taken (according to their instructions) by mouth, at home. *Time* reports the development of such a home treatment. The preventive value of bismuth for syphilis was made clear in the 1920's by Dr M. E. Sonnenberg of Poland, who gave bismuth injections to prostitutes for five years, and obtained 95% protection. For the past ten years, Dr Paul John Hanzlik and his co-workers at Stanford University have been working to put bismuth into practical anti-syphilis pills. Recently they settled on a soluble sodium bismuthate compound which they called "sobisminol". In most patients, two capsules of sobisminol taken with a glass of water three times a day for several weeks healed the surface disturbances and freed them of spirochetes. It also passed into the blood stream and attacked the spirochetes in the blood and tissues. Sobisminol also works as a prophylactic. Taken daily for at least three weeks, it protects against syphilitic infection after the first week. But Dr Hanzlik does not promise complete cures on the basis of sobisminol alone. He and other investigators believe its role for the present to shorten and minimize the course of injections.

Maternal Mortality in India

Very little information was available regarding the causes of maternal morbidity and mortality in India. During the past few years under the auspices of the Indian Research Fund Association maternal mortality enquiries have been carried out in Calcutta and Bombay and another was in progress in 1939 in certain of the urban and rural areas of Delhi Province. As in other countries, puerperal sepsis appears to rank as the highest among the causes of maternal mortality.

Anaemia associated with pregnancy ranks as the next highest. In regard to eclampsia and toxæmias of pregnancy, their incidence appears to differ

geographically. For instance, they are relatively rarer in north-eastern India than in the southern and eastern parts of the country. On the other hand, osteomalacia, producing conditions causing difficult labour, appears to have a definitely higher incidence in the Punjab, Kashmir and north-western India generally. Other investigations relating to maternal morbidity included a study of the toxæmias of pregnancy at the Seth G. S. Medical College, Bombay, enquiries into the anaemia of women in Assam and in Calcutta, and a study of the biochemical and dietetic factors concerned in the toxæmias of pregnancy at the King Edward Medical College, Lahore.

Tracing the Cause of Epidemic Dropsy

EPIDEMIC dropsy is a disease which is widely prevalent in north-eastern India, for instance, in Assam, Bengal, Bihar, Orissa and the eastern parts of the United Provinces. The cause of the disease was for long a mystery in spite of considerable research done on the subject.

It has been shown through epidemiological studies and the results of human feeding experiments, that the accidental contamination of mustard seed with the seed of a weed, *Argemone mexicana*, (known as *sialkanta* in Bengal) which grows wild in the fields where the mustard plant is grown, seems to cause epidemic dropsy. The presence of argemone oil in mustard oil can be demonstrated by a colour change following the addition of nitric acid to the suspected oil, the intensity of colour giving an indication of the proportion of argemone to mustard oil in the mixture. Thus, from the point of view of epidemic dropsy as a public health problem, a considerable advance appears to have been made, because suspected oils can easily be tested and prevented from being sold to the public.

Further, it has been shown by experiments on animals that when argemone oil is heated till it "fumes" well, the toxicity of the oil becomes reduced to that of bland oils, like olive oil or liquid paraffin, although the heated oil still gives the positive nitric test. If these results obtained on animals are confirmed by observations in man, then the heating of the oil till it "fumes" would be a simple method of controlling the disease. This is particularly important in view of the custom prevalent in Bengal of using raw untreated oil in food and for anointing the body.

Endemic Fluorosis in Madras

IN Madras Presidency, a disease is widely prevalent characterised by stiffness and pain in the spinal

region and in the various joints. It has been shown to be one of chronic fluorine intoxication resulting from the continued use of water containing fluorides. The problem of combating it is two-fold, namely, the prevalence of a comparatively wide geographical area of a dental condition, commonly known as "mottled enamel", and the occurrence in a restricted area, of severe manifestations of chronic fluorine intoxication involving the spine, joints and ligaments to which the name of endemic fluorosis has been given. Work is in progress to de-limit the fluoride areas in the province. The presence of mottled enamel in children has suggested a wide distribution of fluorides in drinking water supplies. As regards dietetic factors, in the prevention of this disease it has been observed that even with a high fluoride content of the water used for drinking and cooking, the incidence and severity of chronic fluorine intoxication is greatly influenced for the better by a well-balanced diet. With a comparatively lower fluorine content in the water, an insufficiency of vitamin C and a high calcium value in the diet results in a higher and more severe incidence of fluorine intoxication, even the younger

adult age groups becoming affected; and in the absence of fluorides in the water, these dietetic deficiencies produce neither mottling of enamel nor bone manifestations.

Laboratory experiments on monkeys have confirmed these findings of the field survey. Two factors therefore appear to be important in the production of fluorine intoxication, *viz.*, the presence of fluorides in toxic doses and an unbalanced diet with a pronounced deficiency of vitamin C.

Research work at the King Institute, Guindy on the removal of fluorides from water has not been successful in evolving a cheap method for removing the salts for application under rural conditions. An attempt was then made to see whether a fluoride-free water could be obtained at depths greater than 30 to 35 feet, the normal depth of fluoride-bearing water in Nellore district. A borehole carried to a depth of 300 feet yielded water having a high fluoride content of 3.5 parts per million. The practical solution of the problem of endemic fluorosis should therefore with the present knowledge be sought by remedying the nutritional defects of the population.

Public Health as a Social Service*

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THE address in orienting public health as a social service traces the origin and evolution of the social services as such, particularly as exemplified in England; which, as the home of the Industrial Revolution and of Herbert Spencer, saw the birth of these services that now are world-wide. The Political and Economic Planning (PEP) *Report on British Social Services* (1937) defines social services as: "those services provided or financially assisted by a public authority which have as their object the enhancement of the personal welfare of the individual citizen." The definition of 'public health' to include social scope was first enunciated by Winslow (1920) and has since been modified as follows:—

"Public Health is the science and art of social utilisation of scientific knowledge for medical protection by maintaining health, preventing disease, and curing disease through organised community for (a) the hygiene of the environment; (b) the control of community disease; (c) the organisation of medical and nursing service for the early diagnosis and preventive

treatment of disease in the individual; (d) the education of the individual in principles of personal hygiene and of preventive medicine; and (e) the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health. As such, public health becomes social medicine and is primarily a field of social service, applying practically every basic science directed towards a comprehensive programme of community welfare."

Public health activities 30 years ago were actuated by either or both fear of epidemics and humanitarianism, with limitation of scope largely to control of environmental hygiene and of communicable diseases. Social service became assured in governmental function only in this century and largely since 1914-18. The justification of social service is economic.

The specific question explored in the address is whether public health, in addition to its previous epidemic and humanitarian motives, possesses a social economic basis and, if so, what is the present orientation; and, particularly, whether it has reached the stage of evolution as either a discipline

* Adapted from Dr John B. Grant's Basanta Lecture delivered on September 26 and 27, 1940, at Calcutta University and published with the permission of the University.

or an art to permit postulating principles upon which depends successful administration? The percentage decrease in the death rate from tuberculosis in England and Wales from 1851-1938 was one of the illustrations taken to show the inter-relationship between and dependence of public health upon other social fields than the medical. In England tuberculosis regulations and the community medical machinery for tuberculosis control did not come into effect until 1912 while the decrease in the death rate was proportionately greater between 1851 and 1911 due to improvement in the social-economic condition than after specific anti-tuberculosis measures were begun.

Modern sociology is defined as the 'science' of the origin, growth, structure and function of society. It is on the verge of becoming the art and practice of the collective will of society to procure the fullest potentialities of life from the application of knowledge of the natural sciences through the administrative channels of social services. But as yet only an empirical and ineffective stage of government has been reached and thus corroborating the conclusion that society represents an organism of low degree or a stage of development at which in the animal world the germs of an intellectual faculty are just perceptible. It is universally acknowledged that the immediate and pressing social problem confronting the welfare of the world is to overtake the lag between modern knowledge and its community utilisation. However in spite of the lag in the theoretical desiderata, there has been a relatively significant beginning of social services and without which there could not be the present expression of dissatisfaction with the progress made in terms of that desired. The lag in public health is ascribed to five causes. The outstanding cause of the lag is the absence of scientific *investigation of methods* to apply the results of pure research to groups of population. The four other causes of the lag are: the absence of a public opinion educated in the maintenance of health and the prevention of disease; inadequate economic considerations in planning of administration; the lack of adherence to six essential administrative principles; and finally, the absence of personnel trained in community application of the methodology resulting from scientific investigation. The address amplified the five causes of the lag through detailed exemplifications and indicated steps being undertaken internationally in solution of their causes.

The main point brought out in the address is the unscientific nature of present public health administration as a social service. General principles enunciated by Bernal and Huxley were quoted as to

steps necessary for the social services to become scientific, particularly Huxley's requirement for experimentation in methodology based upon determined principles. The address then, in terms of these general requirements and of experience in public health itself, lays down six postulates for public health administration as a science. These are the interdependence of social services; the achievement of maintenance of health only through the people being themselves possessed of adequate education in and practice of knowledge; the necessity for the administration of special functions being undertaken only by a single governing body; the necessity for compromise in social progress but in terms of the whole design being before the mind; the requirement that administrative procedure must be based upon sound economic consideration and practicable financial budgeting; and, the requirement of personnel trained in administrative methods scientifically derived. This initial enunciation of postulates for any social service administration continues through elaborating each of the postulates.

No single field of social welfare can independently function effectively. This first principle of horizontal articulation is based upon experience of results of social planning. Society is composed of population with a biological heritage, natural resources or the physical heritage, and technical arts or the cultural heritage. Not only must the planned society integrate these three factors but social service implies the correlation of the technical arts themselves. The progress of each is mutually dependent on the average level of progress of all other social fields. Public health cannot progress beyond the effectiveness of education; agriculture beyond communications. The organisation of medicine is inseparable from the social-economic organisation of the community in which it functions. Interdependence of social services is the *first* postulate.

The second fact of medical social service administration is that successful community utilisation of knowledge for medical protection is dependent upon the two fundamental factors: economic-political and education. The development of economic-political is not discussed being beyond the scope of the address.

The *second* postulate is that the final positive goal of maintenance of health can only be achieved by the people themselves through being possessed of adequate education in and practice of health knowledge. The address gave details of the manner in which compulsory education in the United States and England was orienting rapidly towards positive education for citizenship participation, together with

illustrations of the resultant abilities for maintenance of health.

The British Ministry of Reconstruction (1919) called attention in the following words to the defects that had grown up over 70 years in the English Administration :

" It has been the vice of our organisation of the machinery of government that the separate provinces of government activity have been carved out, or permitted to develop, not to fulfil a special purpose for all sections of the population, but to fulfil all purposes for a special section. It is not surprising, in view of the fundamental importance of the national health in all relations of life, that, for each special section of the population in turn, progress in Government activity should discover the necessity for action in matters of health. In the absence of a Ministry of Health, the Departments concerned with each special section retained and developed their own responsibility by means of independent and water-tight machinery ; while in every such section the specialised health provision thus established rapidly became full of duplication and overlapping."

The foregoing was formulated by Sir Arthur Newsholme into the following *third* postulate ; "Good administration requires that when a special function is to be undertaken it should be undertaken by one governing body for the whole community needing the service, and not for different sections of the community by several governing bodies."

This necessity for co-ordination and unity of purpose under one administration will be successful in proportion to fulfilment of certain secondary administrative requirement. Organisation must be in graded units from the polyvalent primary units at the periphery to the base at the top providing specialized function and supervision. Specialised supervision is the key to successful polyvalent peripheral activities. Methodology must be scientifically derived and administered by personnel who are trained through self-participation in the methodology to be administered, and with opportunity for regular periods of refresher training. Administration itself must be checked periodically for efficiency by routine use of appraisals. Centralized direction and decentralized activity is the basis of sound administration upon the principle that too great decentralization limits competence while too great centralization results in ultimate weakness.

An inexorable law is that social change never unfortunately takes place through planned comprehensive schemes but piecemeal, here and there, now

and then, by trial-and-error and opportunistically. The necessity for administrative acknowledgement of compromise constitutes the *fourth* postulate. This principle is so essential to the initiation of new activities but so little, if ever, appreciated by academic theorists inexperienced in bringing new community machinery into existence that, for their benefit, the statement of fact must be supported by authority. The principle has been lucidly expressed by Lord Lytton who, after his return from the viceroyalty of India in 1882 wrote the following :

" The basis of all government, whatever the form of it, and the object of all statesmanship, whatever the direction of it, must always be *expediency*, and expediency alone—nothing more and nothing less—what is expedient, in other words what is good for the entire community, with which a Government is concerned. All that is inexpedient for the community, regarded in all its parts and all its interests, *prospective* as well as present, is bad in government and false in politics. The test of right or wrong is not truth or falsehood, but good or evil. All political action is good or bad, right or wrong, according to its consistency not with theory but with *circumstance*. For circumstances are the only things which Government has to deal with."

" Those human circumstances are not simple, uniform and consistent but infinitely various, fluctuating and divergent. We cannot apply to courses of political action or administrative work the methods which are applicable to trains of reasoning or research ; the object of these latter is to arrive at abstract truth, of the former to bring about good of a particular multitude of human beings, whose condition is extremely composite and whose interests are rarely identical."

" Divine right of royal or other ruling powers or the doctrine of the Rights of Man and Equality of all classes are equally untrue. Government is neither more nor less than the trustee and guardian of the collective interests of a State . . . institutions are not made, they grow ; not logical, simple or symmetrical, but various, intricate and full of salutary anomalies."

It is only the academic theorist who projects whole schemes with the expectation of their immediate community fulfilment. Shaw has said the same thing in "Nothing is ever done and much is prevented by people who do not realize they cannot do everything at once". Lord Lytton's experience is resolved by Sir George Newman in *Building of a Nation's Health* (1939), into the following specific recommendations

to the medical social service administrator, of which three are pertinent to the point in question:—

- (i) Every scheme should express a standard of objective and workmanship which constitutes something in the nature of a national minimum of what is both necessary and practicable in all areas, rather than what might be ideal or desirable if carried out by the most enlightened and competent Local Authorities; such public and representative bodies prefer to feel that there is ample room left for local volition and elasticity;
- (ii) The undertaking only of what is immediately practical and obviously beneficial or advantageous, rather than the adoption of a medical system of higher scientific value and statistical accuracy but less prompt in returns and less obviously ameliorative or remedial in purpose;
- (iii) In health statecraft, central or local, medicine takes not an incidental but an essential share, but it is not always para-medical in purpose;

This fourth principle of the necessity in social progress for compromise between theory and practicability of application results in two ancillary facts to be borne in mind. More immediate progress can be assured through the successful community demonstration of a quarter of one principle than through the abstract enunciation of 100 principles. And, compromise can be successfully entered upon only provided that in so doing the whole design is before the mind.

The results of social service administration are proportionate to the economic soundness of expenditure planning and consequent varying methodology of technical implementation. Much of the ineffectiveness of administration is the result of violation of this principle. It is obvious that there can be no results if a medical service for school health in India, with its annual per capital income of Rs. 65, is planned on the same administrative basis as for England—a country with an annual per capita income of £76 (1931) and where the medical service alone costs 7s. per capita of school population per annum. The consequent methodology problem must first be solved in India before there can be a significant school health programme. The solution lies in the development of methodology whereby the facilities purchased at a cost elsewhere of 7s. per capita, can be applied locally within economic practicability. This can and has been done in countries of relatively low economic standard. This principle is so significant that it justifies illustration. This is taken from China.

The community teaching field established under the Medical College in Peking developed methodology of school health on two economic standards. An 'A' service to demonstrate technical measures common in the West was provided entirely through cash purchase at a cost of Chinese dollars 2'41 per school child per annum (1934). This, however, was impracticable of extension under Chinese economic conditions. Consequently, a 'B' service was developed at 64 cent per capita per annum, which was economically practicable. The latter programme was developed on the basis that the essential measures should be undertaken by voluntary effort of the teachers and the pupils themselves and that cash purchase should be limited to provision of supplies and of technical supervision by the medical officer and the school nurse. This applied to each of the three administrative sections, *viz.*, sanitation, medical service, and health education. The practical essentials are water and sanitary toilets in sanitation; routine appraisal measures of the individual pupil's health and prophylactic vaccinations under medical service, together with correction of acute remedial defects; and, the integration of healthful living and of health knowledge with actual living of the pupil in health education. It was shown that responsibility for the bulk of routines of the school health service could be placed upon the teachers and the pupils provided two essentials were adhered to. These were to train the teachers and to provide adequate supervision of the established routines by the medical officer and the nurse. Teachers appointed in each school in charge of health were designated for special training in a special session during vacations. These summer 'institutes' had practice schools attached with demonstration of health services in the latter, which were also provided in the 'institutes' for the teachers themselves. Teachers were thus given opportunity to instruct themselves in the measures of school health through self-participation as well as being provided with theoretical instruction. The result was provision to the schools of persons competent to be responsible for the categories of measures indicated above. This applied not only to the sanitation of the school environment but the teacher could vaccinate as well as undertake the routines of simple treatments including trachoma; and, he supervised the pupils in their practice of health habits, periodical weighing etc., that the latter undertook themselves through a system of health monitor-ships. Supervision was provided through either the school nurse or the medical officer visiting the school weekly, except when special measures had to be undertaken beyond the capacity of the teacher or the students. This description is sufficient to illustrate that the bulk of the essentials of a school health service can be

discharged through local voluntary efforts rather than through cash purchase, freeing the latter for making available the required technical supervision and medical supplies. In this manner the fundamentals of a service at a cost of Chinese dollars 2'41 and dependent entirely upon purchase was provided for 64 cents through utilisation of trained voluntary effort under technical supervision. But a different administrative methodology had to be devised upon the amount of available cash and which differed greatly in detail, although not in principle, from administration of the school health service provided entirely through cash purchase. Also, utilization of this principle requires that the administrative area is large enough to be self-contained. Obviously a summer institute for teachers would not be justifiable for ten schools only.

The *fifth* postulate is that administrative procedure must be based upon sound economic budgeting. The corollary is that public health administration becomes successful in proportion to the extent of self-participation, directly or indirectly, by the citizen. This fact increases in importance with the lesser economic ability of the community to make cash purchase of medical protection. Control of malaria in Panama is effectively undertaken solely through cash purchase, which is entirely impracticable in Bengal. The social complexity in industrially advanced communities necessitates specialization and cash purchase which however can be substituted through 'self-help' or voluntary effort in the relative simplicity of agricultural communities.

Finally, the *sixth* postulate is that administration will be effective to the extent that methodology has been developed inductively through controlled experimental communities and is administered by personnel trained specifically in the methods. Failure in this principle constitutes the single most important factor for the lag between development of knowledge in the natural sciences and the community utilisation of such knowledge. The reasons for this are elaborated elsewhere.

The purpose of the development of methodology is to assure practicability and fullest efficiency of community utilisation of the results of *pure* research. Utilisation of methodology implies personnel trained in the successful methods. Social administration is effective in proportion to the extent that there is planned correlation and co-ordination between academic research and training and administration.

Training in public health is the most emergent branch of medical education as should be expected

from the fluid picture of practice reported in this address. The function of investigation and instruction in public health is the demonstration of the most efficient and practicable *METHODS* of scientific medical protection through organised community effort and the provision of opportunity for students *to train themselves* in the principles and application of these principles and methods. Both the investigative and the training functions demand the provision of controlled community areas of a size sufficient to permit exemplification of self-contained administrative methods, and to provide quality and quantitative facilities for students' self-participation.

Social background and its relation to public health and disease constitutes no part of medical education as yet although it is now obvious they should be as much as bacteriology or surgery. Perusal of the dicta in the past two decades emanating from such organisations as the General Medical Council of Great Britain, or the Association of American Medical Colleges, reveals that the major recommendation is the necessity for incorporation in the medical curriculum of the preventive and public health aspects of medical knowledge. So far the results of these recommendations are nominal not only because of the vested interests of the older-established subjects but because the recommendations have almost entirely ignored suggestions for the specific means for their implementation. This failure is due to the absence of social experience on the part of the present 'elder statesman' of medical education, who have reached their present senior positions without opportunity for personal experience in undertaking the principle they are recommending, although they can now see its importance. However, this failure seems inexplicable in the light of the prescription by the same body of adequate self-participative facilities for instruction in the pre-clinical and clinical branches of medicine. In fact, today such facilities have almost reached standardisation of what is deemed satisfactory provision. Yet, educators have not seen that adequate facilities for instruction in public health to either the undergraduate or graduate student can be assured only on the same principle as that already followed in pre-clinical and clinical instruction through the provision of opportunity for self-participative instruction in community fields under control of the teachers.

The address concludes with the significant statement that the efficacy of national health administration in assuring medical protection must be in proportion to its fulfilment of the six postulates enumerated; thereby providing a yardstick to measure the soundness of any local administrative policy.

Diet Surveys in India

IN a note prepared for the meeting of the Nutrition Advisory Committee of the Indian Research Fund Association in December, 1939, Dr W. R. Aykroyd, M.D., D.Sc., Director of the Nutrition Research Laboratories, I.R.F.A., Coonoor, summarised the results of over 50 surveys carried out in different parts of India. The Committee recommended that the existing information about the food-stuff composition of diets should be made available for agricultural and animal husbandry departments and utilised as a guide to agricultural policy. Further information on rice diets is available from the Government of India *Health Bulletin* No. 28, summarised from the *Indian Medical Research Memoir* No. 32, recently published (1940).

The surveys included a careful quantitative investigation of all the foods consumed by a group of families—usually about 20—and each survey lasted for a period of 10 to 20 days. This involved daily house to house visits in which all foodstuffs were weighed. At some places surveys were repeated at different seasons. Intake per consumption unit (*i.e.*, per adult man value) of calories, protein, various mineral elements and vitamins have been worked out and, in addition, the average composition of the diets as regards actual foodstuffs determined. It is the latter which is of the greatest value in connection with agricultural policy.

The information already available does however provide a picture of dietary habits over a large part of India. Most of the families investigated belonged to the poorer classes and their diet is typical of that consumed throughout the year by millions in the areas in which the surveys were carried out. While the kinds of pulses, vegetables, etc., taken by the people naturally differ from place to place, in general the nutritive value of different varieties coming under the various headings is fairly similar. Thus, leafy vegetables as a group are rich in vitamin A and calcium, and all vegetable fats and oils consumed in India are devoid of vitamin A activity, and so on. Any differences in the nutritive value of different varieties of the supplementary foodstuffs, which are usually included in the diet in very small quantities, are important in relation to the diet as a whole.

RICE DIET

The majority of surveys have been carried out in rice-eating areas. The important fact emerges that the diet of the poor rice-eater is very similar all

over India. He consumes, in addition to his staple cereal which supplies 80-90 per cent of total calories, very small quantities of other foods such as pulses, vegetables, fruits and meat. Milk and milk products are taken in negligible quantities or not at all.

The "actual" diet of the poor rice-eater in India is represented semi-diagrammatically in Table 1. A well-balanced diet, resembling diets recommended by the Laboratories, is included for purposes of comparison.

TABLE 1.

THE "ACTUAL" DIET OF THE RICE-EATER AND A "WELL-BALANCED" DIET.

(Ozs. per consumption unit per day).

Food.	"Actual" diet.	"Well-balanced" diet.
Rice	15.25	15
Pulses	0.5-1.5	3
Milk	None or negligible amounts	8
Leafy vegetables ...	0.5-1.0	3-4
Non-leafy vegetables ...	2.0-5.0	6
Fruit	negligible	2
Vegetable fats & oils ...	Less than 1.0	2
Fish, meat and eggs ...	0.5-1.0	3 (when milk is absent from the diet or taken in negligible quantities).

(with condiments and spices in small quantities.)

Rice: If the composition of the "actual" diet is worked out in terms of protein, minerals and vitamins, and the results compared with the standards suggested by the League of Nations Technical Commission on Nutrition and other standards drawn up by physiologists, it is found that the rice-eater's diet falls short of such standards in almost every important constituent. Rice however supplies 80-90 per cent of total calories, and the nutritive value of the diet as a whole is in certain respects dependent on that of the main ingredient. Improvement in the nutritive value of rice is therefore desirable. How can this be accomplished? Certain workers consider that the development, cultivation and popularisation of strains of high nutritive value constitute a promising line of attack. Results so far achieved in this direction do not, however, suggest that any striking success is likely to be obtained by this

method of approach. No amount of selective ingenuity could produce a rice which was a rich source of calcium and vitamin A in relation to human requirements. Rice must always be defective in certain essential food elements whatever be the botanical variety or method of cultivation. This question has been fully discussed in an I.R.F.A. memoir published from the Laboratories, entitled *The Rice Problem in India*. Sir John Russell, in his report on agriculture in India has remarked, "In dealing with food crops intended for home consumption the agriculturist should aim at securing the largest and healthiest crops possible, but he need not concern himself with trying to change their composition. The amount of alteration possible is too small to justify the expenditure of time and resources that can better be spent in other ways".

On the other hand, the content of rice in certain important food factors, is greatly affected by milling, washing and cooking. The easiest way of raising the nutritive value of rice as consumed is by minimising the losses brought about by these processes. Parboiled rice, which retains certain vitamins in considerable quantities even when highly milled, is to be preferred to raw rice. The task of ensuring that rice loses as little nutritive value as possible during preparation concerns public health and educational rather than agricultural authorities. It has been fully considered in the memoir referred to. Whole wheat and the various millets have a higher nutritive value than milled rice, and the partial substitution of rice by one or other of these foods improves poor rice diets. This has been demonstrated by animal experiments. It is therefore desirable that the consumption of wheat and millet should be encouraged in rice-eating areas. As regards agricultural policy, this presumably means that special attention should be given to increasing the yields and extending the production of these cereals. The cultivation of wheat in India is limited by climatic conditions but the millets are grown all over the country. They tend however to be regarded as secondary in importance to rice, and are often considered to be an inferior type of food. "Grow and eat more millet" would be a slogan very acceptable to the nutrition worker.

Pulses: The rice-eater's intake of pulses falls short of what is desirable in the circumstances. Pulses supply some of the food factors in which rice is deficient, and constitute a valuable supplement when the diet is based largely on raw milled rice. Agricultural departments in rice-eating provinces should aim at increasing the cultivation of pulses by developing improved varieties, etc. The type of pulse is not of particular importance, since there is

not much difference in the nutritive value of the various species.

Milk: In the majority of the rice-eating groups investigated, the intake of milk, which of all foods, most effectively supplements the poor rice-eater's diet, was negligible, and in striking contrast to the suggested standard of 8 ozs. daily. Wright in his report on dairy improvement has estimated the total milk production of India as amounting to 8 ozs. per capita daily. This figure may however give a false impression of the amount of milk consumed in many parts of the country. For practical purposes the poor rice-eater consumes no milk at all.

Leafy vegetables: Leafy vegetables are particularly valuable supplements to poor rice diets since they are rich in vitamins A and C and calcium. The surveys have shown that intake is everywhere far below the desirable level. Agricultural departments should therefore take up the study of leafy vegetables and endeavour to increase their production. The commonest and cheapest varieties are usually as valuable as the more expensive.

Non-leafy vegetables: Intake of non-leafy vegetables showed considerable variation in the different provinces. In some it almost reached the standard recommended; in the majority, however it was well below this level. While the value of leafy vegetables must be particularly emphasised, there is no doubt that a greater consumption of vegetables of any kind would improve standards of nutrition in India. On this point the Russell Report may be quoted: "Much more work should be done on the cultivation of green leafy vegetables and demonstration fruit and vegetable gardens should be set up adjacent to the villages where they can receive manure and water. A marked extension of vegetable growing is very desirable."

"Special emphasis may be laid on the development of kitchen gardens in villages. The latter has been strongly recommended by the Nutrition Research Laboratories and is now part of the programme of Health Units, etc., working among village populations. In some places considerable successes have been achieved. The villager in many parts of India is not interested in growing vegetables even when land and water for this purpose are available. Education and propaganda are required to teach him the value of vegetables as food and to persuade him to grow these for his own use when circumstances permit. More attention might be given to vegetable growing by agricultural research workers and departments."

Fruits: Consumption of fruit was in general negligible in the groups investigated. Fruits are

rich in various vitamins which are present in insufficient quantities in the poor rice-eater's diet. Mangoes, papaws, tomatoes and oranges are of particular value. Emphasis may be placed on the tomato, a cheap food of high nutritive quality which is being successfully popularised in certain parts of India.

Vegetable oils and fats: The rice-eater's diet is normally very poor in fat and intake is often below 20 grammes daily. This is far below the standards of fat intake usually recommended. While it is not clear whether a low consumption of fat tends *per se* to produce ill effects on the body, it is reasonable to suggest that intake of vegetable fats and oils could with advantage be raised. An increased production of oil seeds by selective and other methods is therefore desirable.

Fish, eggs and meat: In general fish is a food of considerable value in supplementing poor rice diets. Fish muscle can supply various important food factors and small fish, when eaten whole, are particularly valuable because they are rich in calcium. The fishing industry in India is in a very backward condition and a large potential source of good food remains untapped. The yield is a mere fraction of that which could be obtained if efficient methods such as those followed in Europe and Japan were applied. The industry is handicapped by the fact that it is almost wholly in the hands of poverty-stricken fishermen who are unable because of ignorance and lack of capital to take advantage of new and improved methods. Problems of transport, refrigeration, marketing, etc., require a great deal of investigation. It is a pity that at present so little attention is being paid to the development of fisheries because a greater intake of fish would unquestionably do something to improve standards of nutrition in India. Eggs have a nutritive value roughly similar to that of milk and an increase in production is to be recommended for the same reasons. Meat forms a very small part of typical Indian diets and in the existing economic circumstances there is little prospect of a material increase in meat supply.

Sugar and Jaggery: The sugar intake of most of the rural rice-eating groups was nil or negligible. The industrial groups in Bihar consumed sugar under 1 oz. a day. The intake of the families in Delhi province and of the Bombay workers was a little above this level. In South India consumption of sugar and jaggery in general is very small. These figures suggest that the recent increase in sugar production in India has not yet been reflected in a substantial intake of sugar on the part of the

poorer classes. Sugar is a useful food in that it is a concentrated source of energy; it is, however, pure carbohydrate and does not contain the food factors which are most needed to supplement Indian diets. An increase in sugar intake is no doubt desirable, but it cannot be regarded as highly important from the standpoint of nutrition.

MILLET DIET

So far only one millet-eating group in Mysore has been surveyed. Ragi (*Eleusine coracana*) was the type of millet consumed. A study of diet, which is probably typical of millet diets throughout India, shows that its composition, apart from the staple cereal, is similar to that of typical rice diets. While millet diets are of higher nutritive value than rice diets because of the superiority of the staple itself, the former can be improved by supplementary foods in sufficient quantities in much the same way as rice diets. The recommendations with regard to milk, vegetables, fruit, etc., thus apply equally to millet diets.

WHEAT DIET

A relatively high intake of milk and milk products and pulses was characteristic of the groups whose chief cereal was wheat. Whole wheat itself is of higher nutritive value than rice as ordinarily consumed, and wheat diets in India are more satisfactory as regards general composition than rice diets. The amount of vegetables and fruit included in the wheat diet was however too low. If these diets can be regarded as typical of wheat-eating areas in general, it is clear that a greater production of vegetables and fruit should be one of the chief aims of agricultural policy in such areas. The low consumption of vegetable oil and meat is offset by the fairly high consumption of milk and ghee, which nevertheless fall short of the standard recommended in certain of the groups.

TAPIOCA DIET

Tapioca is consumed as a staple food only in Travancore. One survey has been carried out in this State. It was found that the diet of a typical village group was based on both tapioca and rice, the former being consumed in greater quantities. Tapioca has a very low protein content, and in tapioca-eating areas there is a special need for foods rich in proteins of high biological value, such as

milk, fish or meat. Intake of vegetables and fruit was found to be satisfactory in the area surveyed. A diet based largely on tapioca should be supplemented by at least 3 ozs. of pulses daily ; this quantity was not consumed by the group studied. Most of the tapioca-eating areas are adjacent to the coast and advantage should be taken of this to increase fish intake in these areas.

The investigations reported in this note are in line with the following recommendation in the Russell Report :

"The first need in my view is to make a nutrition survey in each province so as to discover what

are the chief deficiencies in dietary ; the medical authorities should then meet the agricultural experts to decide what crops, including fruits and vegetables, should be grown to supply the missing elements. The approximate quantities needed should be indicated, and the agricultural staffs acting along with the rural development authorities should then encourage by all means in their power the growth of these crops".

Let us hope that the programme outlined above should be soon carried out by the proper government agencies.

EFFECT OF SMOKE POLLUTION ON HEALTH

Measurements of daylight in the industrial areas has shown that a considerable amount of visible light as well as a large part of the ultra-violet light is effectively cut off by the smoke clouds in the atmosphere. It is mainly the loss of the ultra-violet light, which sometimes amounts to about 90 per cent, that is injurious to health. Lime is not deposited in sufficient quantities in bones, when there is not enough ultra-violet light falling on human bodies. Children who do not get sufficient amount of ultra-violet light develop rickets. The loss of ultra-violet light also brings about a deficiency of vitamins in the blood, which are so much necessary for the building up of the nerve tissues of our bodies and the stimulation of our blood-cells.

The lack of ultra-violet light affects the vegetation as well as the animals. The clogging of the stomata by the deposit of dark coloured sooty matter further reduces the poor ultra-violet light reaching the leaf tissues. Cows fed on this vegetation yield milk poor in lime salts and children fed on this milk again are deprived of the nourishing matter, lime.

—*Journal of the Gujarat Research Society.*

Research Notes

Inhibition of the "Succinoxidase System" with Extracts of Tumours and Normal Tissues

THE "succinoxidase" system has been found to play a fundamental rôle in cellular respiration. Various investigations have been made to study the distribution of "succinoxidase" in normal and pathological tissues. The succinoxidase activity of certain tumour was found to be very low. R. A. C. Elliott (*Biochem. Jour.*, 34, 1134, 1940) has recently made some interesting investigations to explain this low activity. It has been found that the oxidation of succinate by liver suspension was rapidly and almost completely inhibited by the presence of suspensions or extracts of Walker 256 Carcinoma and Philadelphia No. 1 Sarcoma and less actively by Jensen Sarcoma. The inhibitory effect was also shown by some normal tissues, especially pancreas and spleen. Commercial trypsin also inhibits to some extent. The inhibitor is thermolabile and non-dialysable. It acts on the "succinoxidase" system in a progressive manner, the inhibition increasing with time.

It is now generally accepted that the "succinoxidase" consists of at least three components, dehydrogenase, cytochrome and cytochrome oxidase. The dehydrogenase causes succinate to reduce cytochrome and the reduced cytochrome is reoxidised by cytochrome oxidase. The succinic dehydrogenase and the cytochrome oxidase are both inhibited by tumour extracts. But this is not strong enough to account for the total inhibitory effect on the "succinoxidase" system of liver. Cytochrome c is unaffected. It is thus concluded that the inhibitor acts on some other component, possibly cytochrome b. The "succinoxidase" activity of brain, muscle and kidney is affected similarly to liver suspensions. But the "succinoxidase" activity of heart suspensions is not at all affected and tumour extracts accelerate the succinate oxidation with heart suspensions in presence of added cytochrome c.

P. K. S.

Thiamine (vitamin B₁) in Citric Acid Metabolism

KREBS and others have shown that citric acid plays an important rôle in the metabolism of carbohydrate. This cycle involves two oxidative decarboxylation processes. The first is involved in the synthesis of citric acid from pyruvic acid and 4-carbon dicarboxylic acid and the other is required for the conversion of ketoglutaric acid and succinic acid. It is already known that pyruvic acid is one of the most reactive intermediates in carbohydrate metabolism and co-carboxylase (thiamine pyrophosphate) is essential for the oxidation of pyruvic acid, but no conclusive evidence has yet been furnished to show that co-carboxylase is essential for the synthesis of citric acid. Recently Sober, Lipton and Elvehjem (*J. Biol. Chem.* 134, 605, 1940) have made an attempt to show that perhaps thiamine is essential for the synthesis of citric acid. The evidences furnished by these investigators show that during vitamin B₁ deficiency in rats, urinary excretion of citric acid is appreciably decreased. Further, this citric acid excretion is independent of the inanition accompanying the deficiency. It has also been observed that rats suffering from thiamine deficiency show a decreased ability to synthesise citric acid from injected succinic acid. A 10-fold rise in citric acid excretion in rats has been observed by these workers when thiamine was administered to deficient rats. These results suggest the possibility that co-carboxylase functions in the metabolism of citric acid in the body.

B. G.

Iron-Porphyrin Compounds and Haemocyanin

THE theory of cellular respiration states that oxygen after being activated by the respiratory ferment, cytochrome system, reacts with hydrogen atoms of the metabolites which have been activated by substrates, specific dehydrogenase systems. The latter process consists in the transfer of hydrogen atoms from the substrates to pyridine co-enzymes

under the influence of catalytically active proteins. The actual oxidising agent in cellular respiration is not molecular oxygen but the ferric iron of the Warburg-Keilin system and the function of oxygen consists in the re-oxidation of the ferrous iron formed by the reaction with hydrogen. Now, the iron of the Warburg-Keilin system belongs to iron-porphyrin nucleus which possesses the interesting property of forming three sorts of compounds each of them playing a fundamental part in cellular respiration. Iron-porphyrin may unite with (i) a protein and thus combine reversibly with molecular oxygen without electron exchange (haemoglobin, myoglobin etc.), or may combine with (ii) a protein forming a sluggish oxidation-reduction system, non-autoxidisable (cytochrome *c* and possibly other cytochromes) or, with (iii) nitrogenous compounds giving autoxidisable electro-active systems (haemochromogens, Keilin's 'cytochrome oxidase'). Thus iron-porphyrin compounds may act as mediators between activated substrates and electro-active systems and as final mediators with molecular oxygen.

Ball and Meyerhof in a very interesting paper on the occurrence of iron-porphyrin compounds and succinic dehydrogenase in marine organisms possessing the copper-containing blood pigment, hemocyanin, (*J. Biol. Chem.* 134, 483, 1940) have shown that this pigment also functions in a manner similar to the iron blood pigment. This copper blood pigment has not yet been observed to play any part in the process of oxygen utilization by mammalian tissues which proceeds through a chain of iron-porphyrin compounds composed of a haemoglobin, myoglobin, cytochrome *a*, *b*, and *c*.

Of the marine animals studied, four (*Limulus polyphemus*, *Busycon canaliculatum*, *Homarus americanus* and *Loligo pealii*) possess hemocyanin as blood pigment. They also contain such iron-porphyrin compounds as myoglobin and cytochrome. Cytochrome oxidase and the three cytochromes are present in the heart and some body muscles of all these organisms. All tissues of these animals possessing the cytochrome system are also found to be rich in succinic dehydrogenase which is intimately bound up with it and the general respiratory cycle of mammalian tissues. It is therefore concluded that the process of oxygen utilisation in these organisms is similar to that in mammals except for the substitution of hemocyanin for haemoglobin. The reason for the utilisation of copper instead of

iron by these organisms to form their blood pigment cannot be ascribed to the inability of these animals to utilise iron or to synthesise the porphyrin prosthetic group characteristic of the iron blood pigments. Why animals like *Busycon* should employ haemocyanin for a blood pigment and yet possess muscles rich in the pigment myoglobin, which is very much akin to haemoglobin, is indeed of profound interest and requires to be further elucidated.

S. R.

Factors Influencing the Absorption of Iron and Copper From the Alimentary Tract

ALTHOUGH the importance of iron regarding haemoglobin formation and regeneration has long been recognised, the actual form in which it is present in food-stuffs and the exact mechanism in which it is absorbed by the system have given rise to considerable speculation. Some suggest that ferric iron as such is not absorbed by the system but must first be reduced to the ferrous state in the intestine which contains easily oxidisable materials and has a low oxygen tension. Other workers believe that ferric Fe can be absorbed as easily as ferrous Fe and produces as good a haemoglobin regeneration as ferrous iron.

Tompsett (*Biochem. Jour.*, 34, 961, 1940) states that as the ferric iron becomes non-dialysable and nonextractable with trichloroacetic acid due to the formation of complexes with phosphatide and phosphoproteins present in the food-stuff, it is probable that it is not absorbed as such. Before absorption the ferric iron is first reduced to the ferrous state and this reduction takes place in the stomach by a vitamin like ascorbic acid or by protein. According to the author, as the reduction takes place in acid medium, the gastric acidity of the stomach plays a very important role in the absorption of Fe.

Absorption of copper on the other hand is not inhibited by the presence of phosphoproteins and phosphatides in the diet. From the results obtained by the author it is clear, that the absorption of Cu and Fe is higher on a low calcium diet than on a high calcium diet and is increased by the addition of acid to the diet.

K. C. S.

LETTERS TO THE EDITOR

Socio-Biological Causes of the Fall of France

In recent months the world has had the misfortune of witnessing the fall of the Great French Empire to the Germanic hordes and its slow capitulation under the iron heel of the Nazi. We have been told that the French were taken unawares by being outflanked from the Belgian side where there was no Maginot Line, that the German forces were superior to the French forces in man-power and machinery and that there was treachery on account of the existence of the fifth-columnists in their midst. More than any others it is perhaps the last item that is the most noteworthy.

If we look back into the Hall of History, we can find many nations that have crumpled like a pack of cards before the onslaught of invaders, more virile, energetic and determined to carry through a certain objective. Assyrian, Babylonian, Iranian, Greek and Roman civilizations have all gone back to roost. They have all fallen because of the destruction of homogeneity of their race.

Similar thing has happened with France. For the last 100 years or so she has recorded a falling birth-rate and today she stands the lowest on the list. She is a country that is fast aging, i.e., in a given population there are more aged persons than the young, more young than children. Six decades ago French birth-rate was 23.9 per mille, in 1929 it was 17.7. In the beginning of 1939 it was perhaps much less and now after the war and loss of the pick of manhood it will be further depressed in the years to come. In 1929 German birth-rate was about 18 and since 1933 it has been going up. In spite of falling birth-rate there has been some slight increase in the French population as shown by the country's decennial censuses but that has been found to be mostly due to immigrating foreigners. Taking only those foreigners who are the enemies of the French people today, viz., the Germanic races and the Italians we find that in 1931 there were as many as 148,000 of the former and 808,000 of the latter. Taking total immigration of all nationalities and ages during 1920-30

it has been computed that nearly 2 million persons had entered France. Now, any country whose natural population has been falling and whose neighbours are casting wistful eyes on her stands in a permanent danger of being swamped out. On the top of all these it was at one time found that there were as many as 400,000 illegal, criminal abortions, etc., thus depriving the country of a natural increase of her population. Perhaps most of the foreigners may have taken French nationality. But after all one has to take into account the culture that is brought into an alien country by the immigrant. There is principally a wide gulf between the native culture and the imported one, and the acquisition of a country's nationality can in no way divest an immigrant from the cultural modes of the parent-country saturated in his bones. Besides this there is another factor, that of racial mixture, accentuated by the constant fall in birth-rate. Although the children born of such a miscegenation may be of the same nationality as the immigrant-receiving country there is that diversity of culture and cultural ideas which are homogeneous in the other children. These form a direct menace to the country of their birth since in abnormal times, such as the present war, they may become potential fifth-columnists for the invading country or countries if they happen to be the ones from which they come. Apart from the factor of superior man-power and machinery, this is the major factor that has played its part in the present fall of France. It had its beginning nearly 70 years ago when records show that emigrants from other countries began to invade the French territory. Today that invasion has been consummated.

Perhaps the only country in the world that has sought to fight the immigration menace from diverse countries and nations is the U.S.A. She has enacted laws which are now being rigorously put into practice. But the menace still remains since there are millions who may have by now acquired American nationality and most of whom may be reckoned as potential fifth-columnists. The only course left open to America today is to help

Great Britain in its resolve to crush the German plans of invasion and hegemony, and thus nip the danger in the bud. She can then set about putting her house in order in the light of French analogy.

Bombay,

S. F. Desai.

23-9-1940.

Action of Some Quinoline, Benziminazole and Pyrazolone Derivatives on Paramoecia

The action of quinoline and some of its derivatives on paramoecia has been studied by Grethe¹, Tappeiner², Niederehe³ and others. Brahmachari⁴, *et al* made an interesting observation that, although 6-aminoquinoline and 8-aminoquinoline have no action on paramoecia in strength of 1 : 4000, the introduction of OH-group into these quinoline derivatives raises their toxic action on paramoecia to a remarkable degree.

The effect on paramoecia of some quinoline, benziminazole and pyrazolone derivatives, synthesised⁵ and sent for examination by me, has been kindly studied in the Department of Pharmacology, School of Tropical Medicine, Calcutta. A summary of the results obtained is presented below.

Compound.	Concentration.	Effect on Paramoecia.
(A) Sodium derivative of 1-phenyl-3-methyl-pyrazolone-4 : 5 (2' : 3')-4'-hydroxy-quinoline.	1 : 5,000 1 : 10,000 1 : 20,000	Death after 10 minutes Death in 25 minutes No effect
(B) Hydrochloride of 4-hydroxythiophen-2 : 3 (3' : 4')-2'-hydroxyquinoline-sulphonic acid.	1 : 5,000 1 : 10,000	Death in 13 minutes No effect
(C) Hydrochloride of 1-phenyl-3-methyl-4-(2')-benziminazolylyl pyrazolone.	1 : 5,000 1 : 10,000 1 : 20,000	Death after 1 minute Death after 2 minutes No effect
(D) Hydrochloride of 2-hydroxy-3-(2')-benziminazolylyl-4-methyl-quinoline-sulphonic acid.	1 : 5,000 1 : 10,000 1 : 20,000	Instantaneous death Death after 2 minutes No effect
(E) Hydrochloride of 2 : 4-dimethyl-3-(2')-benziminazolylyl-quinoline.	1 : 5,000 1 : 10,000 1 : 20,000 1 : 50,000 1 : 100,000	Instantaneous death Instantaneous death Death after 10 minutes Death after 18 minutes Death within 45 mins.
(F) Hydrochloride of 2 : 4-dimethyl-3-(2')-benziminazolylyl-6 : 7-benzo-1 : 8-heptadiazine.	1 : 5,000	No effect

From the accompanying table it is evident that the compounds (A, B, C and D) are moderately toxic to paramoecia, whereas the compound (E) is highly toxic to paramoecia—so much so that its antiseptic properties compare very favourably with an equivalent dilution of quinine. So far as the compounds (D and E) are concerned, it is found that the toxicity for paramoecia is considerably enhanced by the replacement of the hydroxy-group in 2-position by methyl (provided the sulphonic acid group does not interfere with the action).

My grateful thanks are due to Bt.-Col. R. N. Chopra for kindly permitting me to publish the above results.

Tejendra Nath Ghosh.

Department of Pure and Applied
Chemistry,
Indian Institute of Science,
Bangalore, 24-9-1940.

¹ *Deutsch. Arch. Klin. Med.*, 56, 189, 1895.

² *Ibid.*, 56, 369, 1895.

³ *Z. ges. Exptl. Med.*, 6, 350, 1918.

⁴ *J. Pharm. Exptl. Therap.*, 39, 413, 1930; 41, 255, 1931; 44, 445, 1932.

⁵ T. N. Ghosh, *Jour. Ind. Chem. Soc.*, 14, 123, 713, 1937; 15, 89, 1938.

On the Effect of Thoria-ceria, Alumina and Manganese Oxide upon a Nickel Catalyst

The highly active particles on a catalyst surface are liable to be easily sintered by heat. Hence these particles lose activity very quickly while catalysing an exothermic reaction. Such particles, however, are likely to possess high chemical reactivity as well. This can be easily measured by the action of acids in the case of metallic catalysts and provides a means for studying the comparative concentration of the active particles. Dilute acetic and hydrochloric acids have been found to dissolve nickel catalyst. The action starts earlier in the case of simple nickel catalyst in comparison with a preparation which contains thoria-ceria in addition. When allowed to be oxidised in a very limited supply of air the latter remains practically unaffected while the former is considerably oxidised. These facts show that particles of comparatively higher activity are present in nickel catalyst prepared without thoria-ceria. The reduction rate of the catalyst is however accelerated in the presence of thoria-ceria. This and the steadiness of Ni-thoria-ceria catalyst are most probably due to the anti-sintering effect of thoria-ceria. The action of alumina is more or less similar but the

oxides of manganese act by producing highly active particles which, however, cannot prevent sintering.

Chemical Laboratory,
Dacca University,
Dacca, 20-9-1940.

K. M. Chakravarty.

The Source of Energy in a White Dwarf Star.

A white dwarf star has for its mass a much smaller luminosity than other stars. For Sirius B, the most accurately known white dwarf, the rate of energy generation (L/M) is 0.007 erg. per gram per sec., and thus during its life-time of 3×10^9 years the energy radiated per gram will be $10^{14.7}$ erg.*

A white dwarf ultimately becomes a 'black dwarf' (a term originally due to Fowler) when it has completely cooled down. It is of some interest to examine the possibility that the star's radiation is all maintained by the very small gravitational contraction which takes place as the white dwarf sinks into the black dwarf stage.** This is done in the present note.

The pressure of ionised matter† at temperature T and density ρ such that the free electrons constitute a degenerate gas and the atomic nuclei (of average atomic number Z) a non-degenerate gas is to a first approximation‡ given by

$$p = \frac{K\rho^{5/3}}{\mu^{5/3}} + \frac{k\rho T}{Z\mu m_H} \quad (1)$$

where the degeneracy-constant K is

$$K = \frac{8\pi h^3}{15m} \left(\frac{3}{8\pi m_H} \right)^{3/2} \quad (2)$$

μ is the mean-molecular weight per free electron i.e., the free electron concentration is $\rho/\mu m_H$. For ionised hydrogen $\mu=1$, and for any other completely ionised

element of atomic number Z and atomic weight A , $\mu=A/Z \neq 2$. m denotes the mass of the electron, m_H the mass of the proton, k Boltzmann's constant and h is Planck's constant. Equation (1) can be rewritten in the form

$$p = \frac{K'\rho^{5/3}}{\mu^{5/3}} \quad (3)$$

where

$$K' = K \left[1 + \frac{kT}{Zm_H K} \left(\frac{\mu}{\rho} \right)^{2/3} \right] \\ = K \left[1 + \frac{5}{Z} \left(\frac{2}{9\pi} \right)^{1/2} \frac{1}{A_0^{2/3}} \right] \quad (4)$$

and the degeneracy discriminant A_0 is

$$A_0 = \frac{h^3}{2(2\pi m k T)^{3/2}} \frac{\rho}{\mu m_H} \quad (5)$$

As the electron gas is degenerate $A_0 \gg 1$.

If we assume (for the sake of an exact treatment) that the distribution of temperature inside the star is such that A_0 remains constant throughout the degenerate stellar core*, then we can treat K' as a constant. The equation of mechanical equilibrium for the star would then reduce to Emden's equation of index $3/2$, and, therefore, replacing K in the usual theory† by K' we have for the radius R of the star,

$$R = R_0 \left[1 + \frac{kT_0}{Zm_H K} \left(\frac{\mu}{\rho_0} \right)^{2/3} \right] \\ = R_0 \left[1 + \frac{5}{Z} \left(\frac{2}{9\pi} \right)^{1/2} \frac{1}{A_0^{2/3}} \right] \quad (6)$$

where R_0 is

$$R_0 = \frac{5^\circ (\omega_{3/2}^{3/2})^{1/3} K}{2^{7/3} \pi^{2/3} G \mu^{5/3}} \frac{1}{M_{3/1}} \approx \frac{2.79 \times 10^9 (\odot)}{\mu^{5/3}} \left(\frac{\odot}{M} \right)^{1/3} \text{ cm.} \quad (7)$$

$\omega_{3/2} = 132.4$ is a number defining the Emden-Solution of index $3/2$, G is the gravitational constant, and ρ_0 and T_0 denote the central density and temperature respectively. The central density is related to the mean density ρ_m by the equation

$$\frac{\rho_0}{\rho_m} = \frac{(\sigma_{3/2})^{3/2}}{3\omega_{3/2}^{3/2}} \approx 5.99 \quad (8)$$

$\sigma_{3/2} = 178.2$ is constant characteristic of Emden's Solution of index $3/2$.

The virial theorem requires that

$$2W_k + W_g = 0, \text{ or } E = (W_k + W_g) = \frac{W_g}{2} \quad (9)$$

where W_k is the total kinetic energy of the particles

* For a white dwarf the core composed of degenerate electron gas contains practically the whole mass of the star.

† \odot is the mass of the Sun.

* The luminosity is assumed to be constant during the life of the star.

** If we assume that the star's radiation is maintained by a conversion of hydrogen into helium, then the amount of hydrogen required per gram of the white dwarf material would be 10.41 gram, for, one gram of hydrogen on conversion to helium generates $10^{18.8}$ erg. However, the rate of energy generation for this exceedingly small concentration of hydrogen comes out on the Bethe-Critchfield formula to be much smaller than the present rate of 0.007 erg per sec. per gram, and thus a larger concentration of hydrogen will have to be assumed. Whether the high-temperature stage that very likely precedes the white dwarf stage would leave this requisite hydrogen-concentration, it is difficult to say, but if it did, the "life" of the star would be much greater than the time-scale of 3×10^9 years.

† The material in the interior of a white dwarf is completely ionised due to pressure-ionisation.

‡ Terms of power higher than one in T are omitted.

in the star, W_0 is gravitational energy and E the total energy of the star. The gravitational energy for a polytrope of index n is

$$-W_0 = \frac{3}{5-n} \frac{GM^2}{R} \quad (10)$$

Substituting for R from (6), we have from (9) and (10),

$$E = -\frac{3GM^2}{7R_0} \left[1 - \frac{kT_0}{Zm_H K} \left(\frac{\mu}{\rho_0} \right)^{2/3} \right] \\ = -\frac{3GM^2}{7R_0} \left[1 - \frac{5}{Z} \left(\frac{2}{9\pi} \right)^{1/2} \frac{1}{A_0^{2/3}} \right] \quad (11)$$

Therefore, the energy available for the star to radiate is

$$\Delta E = \frac{3GM^2}{7R_0} \frac{kT_0}{Zm_H K} \left(\frac{\mu}{\rho_0} \right)^{2/3}$$

and, using (6) and (8) we obtain after a little reduction

$$\frac{\Delta E}{M} = \frac{5}{7} \frac{\omega_{3/2}}{\sigma_{3/2}} \left(\frac{3}{2} \frac{kT_0}{Am_H} \right) \doteq 0.53 \left(\frac{3}{2} \frac{kT_0}{Am_H} \right), \quad (12)$$

where the expression in the brackets is the thermal energy of the nuclei per gram of matter at the centre of the star.

The energy radiated during the life-time of Sirius B is 10^{47} erg. and if all this is to be provided by gravitational contraction, then, assuming the stellar material to be helium, we have

$$0.53 \left(\frac{3}{2} \frac{kT_0}{4m_H} \right) = 10^{14.7}, \text{ or } T_0 = 3.0 \times 10^7 \text{ degrees,}$$

which is a reasonable value for the central temperature of the stellar core. Because of the large thermal conductivity of degenerate matter the core is almost isothermal. The assumption, $\rho/T^{3/2} = \text{const}$ made in the calculation of T_0 , therefore, leads to an appreciably higher* value of T_0 .

If we take the core to be isothermal and of uniform density, then, an easy calculation gives

$$\frac{\Delta E}{M} = \frac{3}{2} \frac{kT}{Am_H}$$

and putting $\frac{\Delta E}{M} = 10^{14.7}$ e.g., we have $T = 1.6 \times 10^7$ degrees.

It is not difficult to estimate roughly the thermal conductivity of dense degenerate matter, and knowing this the temperature of the core can be determined. Calculations² for a model white dwarf ($L = 10^{31}$ erg., $M = 10^{33}$ gram) gave 1.4×10^7 degrees for the central temperature of the core and 1.2×10^7 degrees for the surface of the core, and these values are in reasonable accord with the core temperature that is required if the star's radiation is to be maintained by gravitational contraction alone.

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Delhi, 29-9-1940.

D. S. Kothari

* In fact, higher by a factor comparable to 3.

¹ Milne, *Monthly Notices R.A.S.*, 92, 610, 1932.

Kothari, *ibid.*, 93, 61, 1932.

² Kothari, *loc. cit.*

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Right Thinking*

ON the portals of the University of Uppsala, is to be found an inscription attributed to the philosopher and mystic Swedenborg—"Free thinking is good, but right thinking is better". It sounds a noble maxim, but like all pious sentiments the difficulty begins as soon as one tries to apply it to practical problems; for in all matters which excite human passions, it has not yet been found possible to attach any *objective* sense to "Right Thinking", and in this respect, the moderns are no better than the ancients.

Only three decades ago, the arrogant modern nations used to look down upon the ancients rather superciliously on account of their many irrational actions and ways of thought. How irrational were these ancients, they argued, when the gods of one nation used to be regarded as devils by the neighbouring ones, while to the objective mind of the moderns, no distinction could be discerned between the rival brands of divinity. How wrong was it for a certain people to regard itself as the chosen of god, while others, equally accomplished in arts, crafts and literature were to be regarded as barbarians!

But the events of the last thirty years have shown that in this respect the moderns are no better. During the last World War, which according to the victorious side was fought to make the world safe

for democracy, each side used to consider itself the sole possessor of righteousness, and God Almighty was asked to help the Righteous Cause. So ponderous were the arguments brought forward, not only by politicians and churchmen, but sometimes even by scientific men, in favour of the particular brand of righteousness, that the All-Highest must have found himself as uncomfortable as a High Court judge pitched between two clever lawyers in an obscure case. When after the War, Clemenceau, the French premier, visited the Pyramids, he made some rather arrogant remarks about the vanity of ancient Egyptian Pharaohs who built up an artificial mountain only to house their carcase! He was reminded by an Egyptian paper the next day that probably two hundred years later, the Treaty of Versailles, of which Clemenceau was one of the authors, would be considered as a far worse monument of folly than the Pyramids.

The gods of ancient times have, at the present time, given place to creeds of various designation—Nationalism, Imperialism, Socialism, Marxism, Fascism and Nazism—and wars are being fought over these rival creeds with as much ferocity and ruthlessness as between any two barbaric nations of the past! Who is to find out, in this perplexing plethora of "isms", which is the right one! The saying of the philosopher Hegel, that there is scarcely any human struggle between the absolute right and the absolute wrong, but the struggle is rather between two conflicting views of the right, is after all a counsel of despair!

* A lecture delivered by Prof. M. N. Saha at the Milanese Club, Calcutta, on 18 November, 1940.

But though in matters of politics, sociology and economics, it has been hitherto found difficult, if not altogether impossible, to define 'right thinking', it does not appear to be so in the intellectual field, particularly in subjects which do not excite human passion. But even this was not the case in medieval times, when the steps by which progress had been achieved were completely forgotten and, by the false teachings of religion and tradition, people were rendered psychologically impotent to do any right thinking even in the intellectual field. All knowledge which had been previously built by the patient labours of preceding generations, was supposed to be contained in scriptures and in certain books affiliated to the scriptural authority, and it was universally believed that these were revealed to some prophet or sage. Much of the information about material phenomena was apparently absurd, but if anybody dared to express his opinion freely, he would be visited by excommunications and persecutions in this world and hell-fire of several brands in the next!

Some progressive human minds in Western Europe revolted against this mode of irrational thinking in the 15th century, and approached Nature first hand—by observations, experimentation and rational interpretation of facts. It is usual to ascribe the emergence of 'right thinking' in the intellectual field as a revival of the spirit of the Greeks, who, from 500 B. C. to the beginning of the Christian era were bold enough to dissociate completely the cultivation of knowledge from the cult of gods.* There have been other periods of intellectual revival but the Renaissance is singled out because it is nearest to us in time; it covered wide areas, continued for longer time and accepted all fields of knowledge hitherto neglected or cultivated as a secret lore by the priestly class, namely chemistry, physics, astronomy, biology, medicine, geography, ancient history and geology.

The Renaissance spirit has worked now for over 400 years in Europe in the intellectual and technical field leading not only to undreamt-of increase in human knowledge but also to the birth of new crafts and arts which have entirely revolutionised the older modes of living. Though, originally it was to

some extent shy of politics, sociology and religion, its influence gradually came to undermine the established order in these fields. So great was the success achieved by the Renaissance type of human mind that the French in course of their great Revolution decided to discard their old religion and set up a Goddess of Reason, in itself another irrational act. Right thinking has however not yet been extended in a marked degree to politics, sociology and religion, and this has led to the greatest of human tragedies of the present times, namely colonial exploitation of the less fortunate people by the Europeans as also to the tragedies of the last and the present World War.

Is it not possible to extend the spirit of right thinking to subjects vital to the stability and progress of human society? Unfortunately on account of the false teaching of history the present generation appears to be psychologically unfit to take a broad view of these matters. But probably a philosopher, a few centuries hence, will find the present conflicts to be as irrational as their ancient prototypes. The last war was in effect one for the capture of privileges by the most advanced nations of the world but the present one is claimed to be one between two rival ideologies. But if one surveys the different political doctrines, from the extreme form of imperialistic exploitation to extreme Marxism, it will be found that none is absolutely wicked or absolutely right. As a matter of fact, Russia starting from extreme Marxism is finding that some features of the old order have to be adopted faced as she is with a capitalist world, whereas even the citadels of capitalism find it necessary to introduce varying doses of government control of industry and commerce and of private property. The technique of government is tending to become similar in countries widely different in material prosperity and historical tradition, and certain controversial doctrines which are supposed to form the essential elements are not found to be so after the experience of a few decades. Both Nazism and Fascism are based upon ideas of race superiority and prescription of a lower standard of life for inferior people. These doctrines are largely sentimental and may be discarded when political ambitions are satisfied. The great democracies of the world have apparently condemned ideas of race superiority, but there is a vast difference between their professions and practices. For example, the great democracy of America has got within its borders 15 millions of coloured people whose only representatives in the House of Representatives are a few janitors. The

* Modern research has shown that every people who have achieved a certain amount of greatness had a 'period of rationality' when the seeds of their future were sown, e.g., the reign of the first few dynasties of ancient Egypt, the period of Sumerian City States in the Near East and the period following Upanishadic and Buddhist thought in India.

British Empire has been proclaimed to be more liberal than its Roman counterpart of ancient times, but it has still to pass a law like the edict of Caracalla which conferred Roman citizenship on all people within the Empire of Rome. So when we are given lectures on the advantages of democracy by the so-called advanced nations of the world, it is probably only meant for local consumption, and, for the less fortunate races, such slogans are simply misleading. History has shown us again and again however that those who are guided by false ideas of racial superiority have sooner or later suffered for it.

In this country unfortunately there is no right thinking even in the field of knowledge, not to speak of politics, sociology and economics. An objective mind looking at the present welter of conflicting ideologies in India may justly compare the different parties and communities to so many swarms of fish struggling in a net, each pulling in a different direction. For a short time there was a spirit of unity due to a sense of collective injustice, but as soon as the chance appeared that some of this injustice may disappear, the old prejudices and mental barriers which have been inherited from a false teaching of history start doing their nefarious business. There can be no escape from this state of affairs unless the problems are approached in a spirit of true and impartial enquiry.

Some might argue that it is quite impossible to discuss matters involving politics, society and religion in an objective way. This has not been the experience of some of us who had the privilege of taking part in the deliberations of the National Planning Committee. The members of this Committee represented all shades of opinion—from capitalists to professed communists—industrial and academic men and probably there were as many shades of political opinion as the number of members. In the personnel of the 29 sub-committees which were formed for discussing particular subjects there were all kinds of divergent opinion and the subjects themselves,—industries, labour, control of currency and banking, industrial policy etc.—were such as

usually excite the bitterest controversies. Yet it has been the experience of the members of the sub-committees and the National Planning Committee that when the problems in each of these subjects were properly studied and analysed in an objective manner, the solutions practically took the same shape in everybody's mind, and it was possible to reach a very large measure of agreement even on the most debatable points. It therefore does not appear impossible to apply the principle of right thinking even to political and economic problems. But the present generation of political leaders are to a great extent psychologically unfit to approach the problems in such an objective way. A new type of mind must be created for this purpose. It however remains a moot question whether, even when scientific solutions of political, economic and social problems are obtained, they can be put into practice without a bitter struggle.

A Greek historian, Polybius, who spent a number of years in Rome as a hostage and had the privilege of making the acquaintance of the most eminent Roman statesmen, asked himself this question: Why in politics were the Greeks utter failures, while the Romans, who were only their pupils and had very little pretensions to originality, attained unique success? He considered that the explanation lay in the judicious blending of monarchical, aristocratic and democratic elements in their constitution. In other words, the Greeks were guided by abstract reasoning in framing their constitution, while the Romans built up the fabric of their State by the experience gained in long and arduous struggles, choosing the better course in all their vicissitudes. The constitution was not a product of one man, but of many, and had been perfected not in a single lifetime but in the course of several ages and generations.

If a proper political and economic constitution is to emerge out of the present chaos, it can only happen if the problems are approached in an objective manner and if the real lessons of history are remembered and properly utilised in the interest of the entire community.

Recent Technical Development in Wireless and Broadcasting in Great Britain

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(Continued from the last issue)

THE BRITISH BROADCASTING CORPORATION

THE next important establishment visited by the author was the British Broadcasting Corporation. This is the biggest broadcasting organization in the British Empire and is one of the largest in the world. The B. B. C. was founded in 1922 as a limited liability concern and on 1st January, 1927, became a public corporation working for national interest. The whole organization is broadly divided into four main sections: Engineering, Programmes, Public Relations, and Administration.

The author was primarily interested in the engineering section which is sub-divided into seven departments—Overseas and Engineering Information, Maintenance, Station Design, Lines, Equipment, Civil Engineering and Research. The Overseas and Engineering Information department collects information about the reception of B.B.C. programmes at home and abroad and gives technical advice to listeners. The Maintenance department, as the name implies, is responsible for the proper maintenance of all the transmitters, studios, aerials and control room equipments of the B. B. C. stations. The Station Design department is mainly concerned with the design and testing of transmitters and other relevant equipments. The Lines department is in charge of all the ordinary and "music" telephone lines rented by the B. B. C. from the British Post Office for broadcasting purposes. The Equipment department is concerned with designing and constructing all low frequency apparatus and switching equipments in control rooms. The Civil Engineers' department looks after the planning and maintenance of all the B. B. C. buildings and transmitting aerial masts. The Research department is responsible for the development of the technical equipments of the B. B. C. and works in

co-operation with other Engineering departments and with manufacturing companies.

Through the Overseas and Engineering Information department the author had the opportunity of studying the technical details of the following typical long- and medium-wave B. B. C. transmitters.

(a) *The National Transmitter at Droitwich:* This transmitter is tuning-fork controlled and the wavelength of radiation 1500 metres. The aerial system is of the T-type supported by two 700 ft. masts and the aerial power is 150 Kw. Series modulation in the penultimate stage ~~has been~~ adopted in the transmitter. The penultimate stage thus consists of two distinct and separate sections connected in series, one audio frequency and the other radio frequency, each running with 10 Kv on the anodes, the total H. T. supply being 20 Kv. The audio frequency section has got four 10 Kw. water-cooled valves connected in parallel and the radio frequency section four 15 Kw. water-cooled valves.

The output stage is a balanced push-pull modulated-high-frequency stage using six water-cooled valves each capable of a maximum output of 50 Kw. Two of the valves, one on each side of the push-pull, are kept as spare. With two 50 Kw. valves on each side, therefore, the required output power of 150 Kw. is obtainable without running the valves at their full load rating.

A special precaution has been taken in the design of the transmitter for getting good fidelity. The output of the final push-pull stage passes through a "transducer" and thence to the transmission lines connecting the main station building to the Aerial-transformer house. The transducer unit contains specially designed h. f. circuits, the main function

of which is to reduce the attenuation of the higher audio frequency sidebands, thus enabling the long-wave transmitter to have a fairly uniform frequency response up to about 9 Kc/sec.

(b) *The Regional Transmitter at Start Point*: This transmitter has been opened in 1939 and has an aerial power of 100 Kw on 285.7 metres. In common with all recent B. B. C. transmitters, high-level "Class B" modulation has been used. Further, negative feed-back has been applied to the modulator system to reduce the total harmonic content. It may be remarked that with the general increase in power of transmitters, the cost of the power to run a station becomes a major item in the operating costs. The Class B high-level gives a good overall efficiency and is now being universally used by the B. B. C.

The aerial system at Start Point is of particular interest and is of a type not before used by the B. B. C. The location of this station is responsible for this. Sea being to the south, the aerial system was designed to increase radiation to the East and the West and to reduce it to the South. The aerials are in the form of two mast radiators 450 feet high and spaced 350 ft. apart (about $\frac{3}{8}\lambda$). One mast is excited directly and the other through a phase-shifting network adjusted to produce the required polar diagram. Each mast rests on porcelain insulators and is stayed by three groups of stays, each stay being in turn broken up by insulators. The aerials are fed by concentric feeder lines leading into two aerial coupling circuits which are contained in two small buildings immediately next to the bases of the masts. The building nearer the transmitter contains also the phase-shifting network.

(c) *The Receiving and Frequency Checking Station at Tatsfield, Surrey*: This station is attached to the Overseas and Engineering Information department. Here some of the B. B. C.'s receiving work for relay of important foreign broadcast programmes is done. For important relays, however, the B. B. C. usually rely on the single-side-band receiving system of the British Post Office, which has been referred to in our last article. At Tatsfield, the frequencies of all B. B. C. transmitters are measured carefully and any deviation is at once reported to the station concerned.

The system of reception at Tatsfield is of the Diversity type using horizontal rhombic aerials. Usually two rhombics are used in conjunction with two receivers, the rhombics being separated by about

6λ for the mean working wavelength. It may be noted that reception at Tatsfield for relay purposes is mainly of broadcasts from U. S. A. As the angle of incidence of these downcoming short waves varies within a certain limited range, the two rhombics are of two different dimensions so designed as to cover, on the average, the entire range, the optimum workings being at 18° and 22° respectively. These values are chosen because the variation of the angle lies between 16 and 24 degrees with the horizontal. The one designed for 18° satisfactorily covers signals varying between 16° and 20° and the other between 20° and 24° .

The audio outputs of the two receivers are paralleled through volume control potentiometers and phase reversing keys. There are also controls by means of which the receivers may be used independently of one another, i.e., the output of only one may be fed to the line.

The coupling of rhombic to the concentric feeder leading to receiver is also of special interest. The input impedance of a properly terminated rhombic is about 800 ohms. An 800-ohm line is, however, somewhat unmanageable. A concentric feeder which has a special advantage because of its very low noise pick up voltage is therefore used, though its impedance is considerably less than that of the input impedance of the aerial. The system of coupling is shown in Fig. 3.

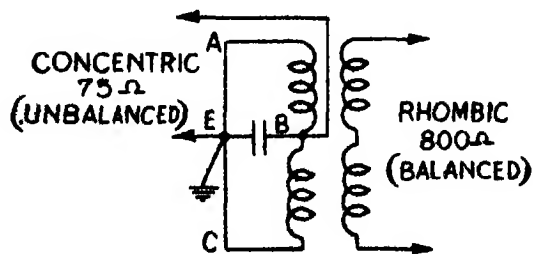


FIG. 3

It will be noticed that at any instant if A is positive with respect to B, C is also positive with respect to B because of the opposite senses of winding of the sections AB and BC. The current through the coaxial load due to both the halves AB and CB of the coupling coil is in the same direction at any particular instant.

The Empire Station at Daventry: Towards the end of 1927 the B. B. C. inaugurated experiments on long distance short-wave broadcasting after the manner of the American and Dutch stations. It soon

became obvious that there was a great demand throughout the Empire overseas for B. B. C. programmes and on 19 December, 1932, a regular service to serve the whole British Empire was started by the B. B. C. from two short-wave transmitters at Daventry. Various experiments have since been carried out to improve and expand the service. The original aerial systems and the two transmitters with which the service started are no longer used and have been replaced by more efficient ones of latest design. Initially, the duration of service was 10 hours a day; now it is 18 hours with a range of wavelength from 13 to 50 metres. There are now six periods of transmission which are so arranged that each corresponds to an evening period (which is most convenient for listening) in some part of the Empire for which that particular transmission is intended. The wavelength and aerial system are changed to suit each particular transmission and, in general, four transmitters on different wavelengths radiate simultaneously during each Empire transmission. This makes reception more reliable for, out of these four, there is always at least one which is best suited for reception, either on account of its wavelength or due to the special disposition of the corresponding aerial system.

There are at present in service 8 transmitters, two having output of 10 to 15 Kw., one 20 Kw., and the remaining five about 100 Kw. These last five, however, normally operate at an output of about 50 Kw.

From the very early days of the Daventry station various experiments have been carried out to determine the best type of aerial system for a particular service. Obviously, omni-directional aerals involving unnecessary loss of energy in the undesired directions should be avoided for Empire service. The transmissions from the aerals at Daventry are not, however, what may be called "beam" transmission, because each transmission covers a horizontal sector subtending 36° at the aerial, the central "line" of which is directed towards the country to be served. The propagation conditions in the vertical plane are variable and the corresponding polar diagrams are to be adjusted to suit these varying conditions. The variations in the ionosphere with the time of the day and the season of the year necessitate adjustments of the angle of radiation and the width of the main lobe in the vertical plane to suit the particular transmission. At the present imperfect state of our knowledge of the ionosphere, the design of these

aerial systems is still more or less of an experimental nature. According to tests which have so far been carried out by the B. B. C., aerial systems with stacked horizontal dipoles seem to be better than vertical aerals. It has also been found that about four horizontal elements in the vertical plane are sufficient for a good transmission. Further, for satisfactory results the best average height, above ground, of the bottom element has been found to be about one wavelength and the separation between elements $\frac{1}{2}\lambda$. Nearly all the aerals are provided with reflectors—this not only increases the radiation in the forward direction but also greatly reduces any back echo at the distant receiver. The reflectors are all parasitically excited, the distance between radiator and reflector curtains being $\frac{1}{4}\lambda$. The designs of the radiator and reflector elements are identical and there is provision for interchanging the two curtains so that the direction of radiation may be reversed.

A few notes on the feeder lines and their matching as in use at Daventry may be of some interest here. From various considerations balanced open-wire type feeders are almost universally used. Matching is mainly done in three stages:—Firstly, the extreme end of the feeder line is stub-matched at the array terminal (points A, Fig. 4). The main line

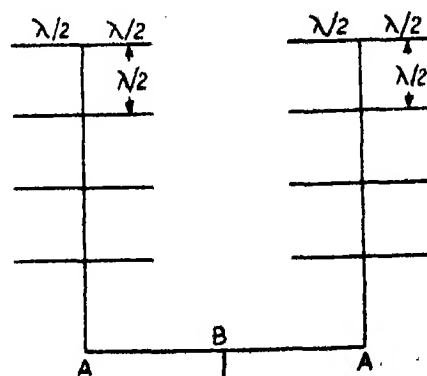


Fig. 4

is then matched at point B. After this, the whole transmission line is checked and any mismatching or standing wave due to irregularity in the line is remedied either by short lengths of lines or line-matching condensers which consist of insulator rods (spacers), with corona rings or discs. The final matching is done at the beginning of the line just after the switching system which connects any transmitter to the desired aerial. Here too, stub-matching is adopted; as far as possible short-circuited stub-matching is used because of its easy manipulation.

In the latest transmitters the B. B. C. are using four-wire lines between transmitter and the switching system connecting the transmitter to the desired array. It may be noted that this portion (about 75 metres) of line has to carry currents of different frequencies to suit the particular array used. But, as a matching (after switching system) made at one frequency may not hold for other frequencies, there is possibility of standing waves being formed in this portion of the line with consequent chance of flash-over.

The surge impedance of a four-wire line (two in parallel, with spacing in-between, as one wire of a twin line) varies with the spacing between the two conductors of each line. Obviously as the spacing is decreased, the surge impedance gradually approaches the value for a twin wire line as shown in Fig. 5.

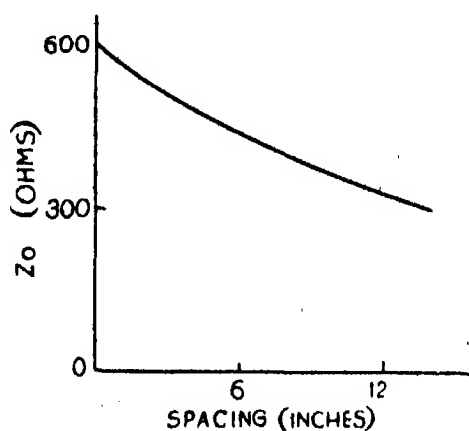


FIG. 5

No. 6 hard-drawn copper wires with 12" spacing between any two consecutive conductors are used by B. B. C. and such a line has surge impedance of about 320 ohms.

The B. B. C. have lately adopted a different system of feeding high power arrays. The advantages of the new system will be easily understood if we compare Figs. 6(a) and 6(b). It may be recalled that the standing waves on the interstack feeder (Fig. 6a) impose a limitation on the power that can be used. In the new system (Fig. 6b) the power in the interstack feeder is halved. It is obvious that if an even number of dipoles is used in each vertical stack then the feeders are still balanced. For example, if the end-impedance of a $\lambda/2$ radiator is roughly 2,000 ohms, then the impedance between A and B (Fig. 6b) looking into the array is 2,000

ohms, there being 1,000 ohms load (two 2,000 ohms in parallel) on each wire of the twin-wire feeder. This system of feeding, therefore, equally divides the total power in the two interstack feeders. It has the further advantage that the single bay of push-pull

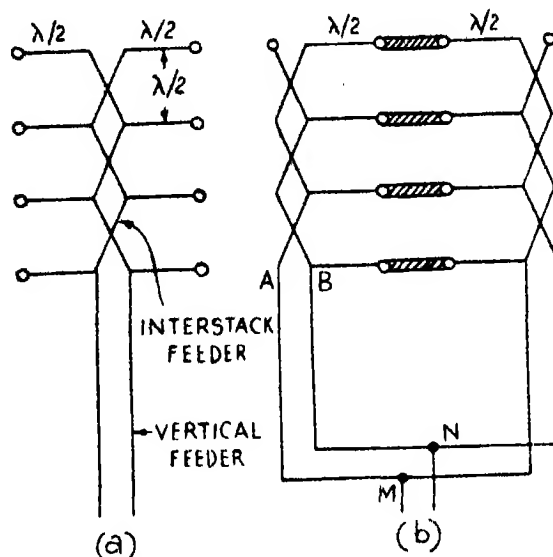


FIG. 6

dipoles can be slowed for rotating the direction of the transmitted beam. This is not possible when a single bay is fed in the normal way by a single feeder.

Filtration of harmonics. The B. B. C. take special care to prevent the harmonics, generated by the high-efficiency amplifiers, from reaching the radiating system. The second harmonic is filtered out by means of $\lambda/4$ (quarter wavelength on fundamental) short-circuited lines. Such a line behaves as an infinite reactance on fundamental but as a short-circuit on the second harmonic. The ideal place of such a filter would be directly at the transmitter output but as each B. B. C. transmitter is required to operate on a number of spot wavelengths, the filter is located after the switching system connecting a particular transmitter to the line leading to the desired array system. As a further precaution against second harmonics, the downcoming feeders from each vertical stack of push-pull dipoles are anchored firmly to the ground by means of short-circuited $\lambda/4$ lines, the short-circuited end being earthed. This arrangement not only acts as a second-harmonic filter, but also as an earth connection for lightning discharges.

No special precaution is taken for filtering out the third harmonic because the tuned coupling to the

feeder definitely discourages any third harmonic being present in the output.

SOME SPECIAL FEATURES OF DAVENTRY TRANSMITTERS

Of the five high power transmitters of recent design two have been supplied by the Standard Telephones and Cables Limited and the other three by the Marconi's Wireless Telegraph Company Limited.

(i) *The Standard Transmitters*:—These use Class-B high level modulation and the transmitters are designed for four spot frequencies. The most interesting feature is the design of the final r.f. power amplifier in which, contrary to usual practice, the grids are earthed and the filaments are at r.f. potentials. Such amplifiers are called "series-connected" or "inverted". The schematic arrangement and the equivalent circuit (for only one valve of the push-pull) are shown in Figs. 7 (a) and (b).

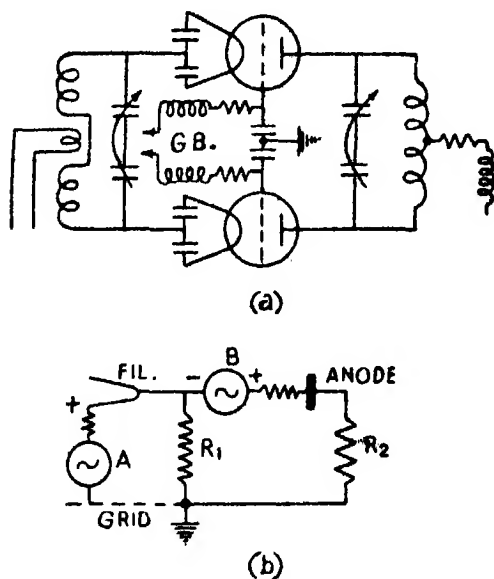


FIG. 7

It will be observed that the earthed grid between the anode and filament eliminates or minimizes direct transference of energy, through the valve, between the input and output circuits. Moreover, this earthed grid means inherent negative feed-back in the amplifier and, for stability, balancing condensers are either not required at all or they are of extremely low values. Leaving stray capacity out of account, the anode-to-anode output circuit capacity due to the valves themselves is equal to one half of the anode-grid capacity (C_{ag}) of one valve. This is to be

compared with double this value, i.e., equal to C_{ag} , for the case of the classical neutralized amplifier. Consequently this is a great advantage in high power short wave transmitter design because larger valves can be used before the limits imposed by excessive inter-electrode capacity are reached.

From the equivalent circuit it is obvious that the exciter (A) supplies power to the grid circuit (R_1) as well as directly to the output load (R_2), since, so far as R_2 is concerned, the exciter (A) and the equivalent anode circuit e.m.f. (B) are operating in series and in phase. Thus the exciter stage for an inverted amplifier has got to supply more power than for a normal amplifier. The extra power is, however, directly transferred to the output load and usefully employed there. In many practical cases, it is very advantageous to be able to draw power from the exciter and use it to augment the power delivered by the final stage. Such is the case when it is desired to obtain the highest possible output on short waves without paralleling output valves. When limitation due to size of valve is reached, the inverted amplifier gives further increase of output because of the power from the exciter. It may be remarked in this connection that since the exciter and the final stage supply power to the output load, both these stages are simultaneously modulated.

The efficiency of this system, expressed as the ratio of the output power to input power to the anodes of the two stages is, of course, not greater than the efficiency of a normal amplifier but in practice, for the same degree of stability, the inverted amplifier gives greater effective efficiency. In the normal case it is in general necessary to incorporate some damping resistance across the grids of the amplifier valves. This resistance absorbs power from the exciter which, in the inverted system, would be transferred to the output load.

The elimination of large anode-to-grid balancing condensers greatly reduces the tendency of parasitic oscillations. This advantage is of special importance in the design of high power short wave transmitters because as the size of the valves is increased with resulting increase of inter-electrode capacity, the resonant frequency of balancing condenser circuits becomes nearer and nearer to the operating frequency which makes selective damping of the parasites more and more difficult—almost impracticable.

The elimination of anode-to-grid balancing condensers is very advantageous in transmitters designed

to operate on a number of spot frequencies. The change over from one frequency to another can then be effected very quickly because the balancing condensers do not require accurate adjustment for each frequency. In a practical inverted amplifier, however, a certain adjustment which varies with frequency is necessary, but the adjustment is not at all critical. This adjustment is due to the unavoidable inductance in the connections between grids and earth, due partly to the connections themselves and partly to the grid leads inside the valves; this inductance is, in effect, a coupling impedance between input and output circuits giving undesirable reaction. To avoid this the inductance is neutralized by series tuning capacities, the values of which have obviously to be altered with frequency, though not very critically.

Since the filaments of inverted amplifier are at r.f. potentials, they are heated by A. C. supplied through special shielded transformers having low capacity between the secondary and the grounded shield between the windings.

(ii) *The Marconi Transmitters*:—Of the three Marconi transmitters, one incorporates Series modulation and the other two, which are the latest, Class B—all high level. The first one employs a method of modulation control which may be understood from the simplified scheme shown in Fig. 8. The filaments

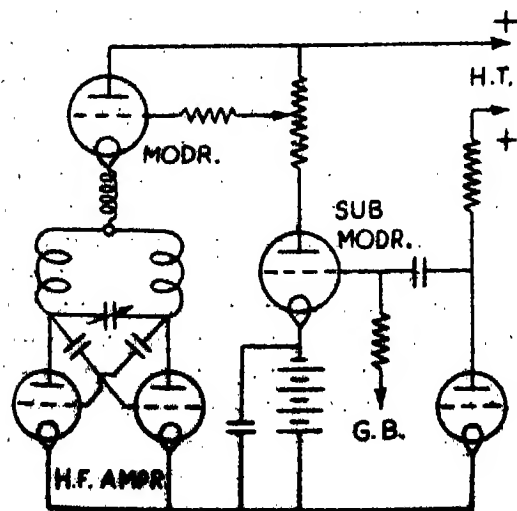


FIG. 8

of the h.f. amplifier valves are earthed and connected to H.T. negative. The h.f. circuit is of the usual centre-tapped tuned-anode type and the modulator

valve is connected between the H.T. positive and the tap. This arrangement simplifies the design of the h.f. circuits but simultaneously introduces difficulties in feeding the audio input and supplying grid bias for the modulator. A special sub-modulator system has therefore to be designed for this. The sub-modulator valve including a series anode resistance is arranged in shunt across the H.T. supply and a tapping on this resistance is taken through a squegger resistance to the grid of the main modulator. The tapping is so adjusted that the modulator grid takes up the correct potential relative to its filament and anode. Such an arrangement would not give 100% modulation owing to the fact that when the main modulator acquires its maximum positive grid swing, i.e., when the sub-modulator is 'cut-off', the voltage across the modulator cannot fall to zero. In consequence an additional bias voltage (actually a D. C. generator) has been used in series with the sub-modulator cathode and this enables 100% modulation to be obtained.

Another feature of this type of modulation is that the circuit arrangement lends itself without much alteration to a "floating carrier" system by which the strength of the carrier is made to depend on the modulation depth. By this means a large amount of power can be saved during periods of weak modulation. Although the designers have made provision for this floating carrier the B. B. C. do not use this method of carrier control because in such a case, receivers fitted with A. V. C. would give greater noise during silent periods and periods of low modulation.

Research Department:—The Research Department of the B. B. C. is located at Nightingale Square, a suburb of London. This department is entrusted with the experimental development of the transmitters, aërials, studios and other equipments used by the B. B. C. It deals with all the technical problems and difficulties of the B. B. C. and acts in close co-operation with other engineering departments and various manufacturing concerns.

Of the problems which were being handled during the author's visit, special mention may be made of the development of a new type of high-efficiency system for broadcast work. The earliest of the so-called high-efficiency system is the out-phasing-modulation system of Chireix (1935). The next one was the high-efficiency power amplifier for modulated waves due to Doherty (1936). Terman

also developed a high-efficiency grid-modulated amplifier (1938). Very recently (1939) Vance has also developed a high-efficiency modulating system.

At the time of the author's visit the B. B. C. Research Department was busy developing and improving upon the Fortescue method of amplification of modulated h.f. which should also have high efficiency when the unmodulated carrier alone is present. In previous systems of this type the practice had been to use two amplifier valves in the output and to feed each valve with input power modulated to a wave form identical with the modulated envelope required at the load. One valve, however, is biased beyond cut-off so that it only comes into operation when the input envelope exceeds the carrier value.

The B. B. C. are using a pair of amplifiers connected to a load and impedance inverting network in the form of a mutual inductance. Neither amplifier, however, has abnormal bias and both have input A. C. envelopes in which the modulation depths differ from that required at the load. In the special case, actually used by the B. B. C., the input to one is pure carrier and that to the other contains the side bands together with some modulated wave. By suitable adjustments the system works very satisfactorily; the distortion measured at 100% modulation is only about 3.5%. Regarding efficiency it may be noted that the first output valve dealing with carrier only, operates at an efficiency of about 75%. The second valve is run as a linear (with respect to the h.f. envelope) amplifier and takes practically no current in the carrier state. The overall efficiency of the pair is thus about 70% and is practically the same as that of an amplifier for unmodulated carrier.

The Research Department is also developing a new type of anti-fading aerial system. Normally half-wave radiators are used for this purpose but considering broadcasting on medium waves, it is very costly to erect such masts. The most important factor which the B. B. C. have to consider is that in the vicinity of a big city like London, the Air Ministry would not allow the erection of such high masts because of danger to Air navigation. In 1938 Hansen and his associates in America showed analytically that an aerial system consisting of a ring of vertical radiating elements would radiate mostly along the ground and that these elements need not be very high. In 1939 they further showed that a single ring is better than a multiple ring. The B. B. C. are carrying on experiments, for the first

time in England, with the object of using such an aerial system at their London Transmitter at Brookman's Park.

The Research Department is also making various experiments in connection with studio design. It is needless to emphasize that the quality of a broadcast programme depends to a very great extent upon the acoustic properties of the studio. It may be mentioned that even after long practical experience of many years the B. B. C. have not yet been able to come to any definite specification or formula regarding the proper treatment of studios. Usually they distinguish between four types of studios—talk, production, orchestral music and dance music. The average size of their talk studio is $13' \times 16' \times 10'$ (height) and the reverberation time is about 0.3 to 0.4 second which, for good performance, should be practically constant over the audio range, *i.e.*, from 50 to 8,000 cycles/sec. It is desirable to have the time rather decreasing with decrease of frequency in this range. The reverberation time for a production studio of 50,000 to 100,000 c.ft. should be about 1 sec. This studio is usually divided into two compartments resulting in an acoustic coupled circuit. For orchestral music studio of size 10,000 c.ft. the reverberation time should be about 0.9 second and for 100,000 c.ft. about 1.7 second. In this case an increase of reverberation time with decrease of frequency between 100 cycles and 50 cycles is sometimes desirable. For dance music the average size is 30,000 c.ft. and reverberation time about 0.7 seconds. Some distinction is also made between the ceiling and the walls of a room for their acoustic treatment. The ceiling is covered with intermittent patches of Rock wool with a total surface area of about one-fourth of the ceiling. For the walls, about one-third of the height just above the floor is covered with wood panels; one-sixth just below the ceiling is covered with Rock wool and the remaining intermediate portion is covered alternately with patches of Rock wool and Newtonite. Celotex is not usually employed because it absorbs moisture and soon loses much of its sound absorbing property. Rock wool is not much affected by moisture.

THE STANDARD TELEPHONES AND CABLES, LIMITED

The last important establishment visited by the author was that of Standard Telephones and Cables, Limited, at New Southgate, London. The Standards are one of the biggest manufacturers of Wireless

transmitters of all varieties, special receivers and telephone equipments.

The main laboratories of this company in England are at Woolwych and New Southgate, both suburbs of London. The Woolwych laboratories are mainly concerned with the design, development and manufacture of valves and low-frequency and telephone equipments. The radio laboratories are centralized at New Southgate under direct control of the chief engineer Mr. C. E. Strong. The author being primarily interested in the design and testing of broadcast transmitters, concentrated his work in these laboratories. The activities of the Transmitter section of the Development Department are subdivided into four divisions—high power, medium power, low power and aircraft. Each division contains workers specialized in the job and there is close co-operation between the different divisions.

It will not be possible to describe here the activities of the different sections but a brief analysis of some work with high power tetrodes, which the author closely followed, may be of interest. The investigations were carried out in connection with the development of the penultimate stage for a 150 Kw. shortwave broadcast transmitter (B. B. C. order). The final stage was intended to work on the inverted principle and it was estimated that about 20 Kw. would be required out of this penultimate stage. This stage was therefore designed to work with four VLS 413 (Standard) tetrodes in parallel-push-pull (Max. anode diss. 15 Kw., Sc. grid dissn. 800 watts, Max. anode voltage 11 Kv., $\mu=300$, $g=5$ mA/v, $V_i=41$ V, $I_i=70$ A, Total emission 10A.).

The circuit scheme was normal. The exciter output (72 metres, crystal controlled) was led in by means of a concentric feeder and was magnetically coupled to the grid circuit. This was first tuned with ordinary condenser but it was found that the grid feeds were unbalanced. The grid tuning condenser was then changed into the split-stator type and the unbalance was practically removed. The load was inductively coupled to the anode tank circuit and consisted of a line with heavy dissipation and terminated in a bank of lamps. With the exciter "on", the anode and line circuits were next tuned in the "cold" state, i.e., without any H.T. Finally, with the different circuits properly tuned, the drive was cut-off and H.T. applied. By swinging the anode circuit through resonance it was found that the system was quite stable. The tests were repeated

a number of times and the stability on 72 metres was confirmed.

Stability and modulation tests on 55 metres:— The wavelength of operation was then changed to 55 metres. The amplifier seemed stable but on very careful tuning throughout the range of grid and plate tuning condensers, the 10A. H.T. fuse blew off. The violence indicated parasitic oscillation and was completely eliminated by using 50 ohms resistance in place of the h.f. choke in the H.T. lead. The amplifier was next "driven" and from the input and output figures, the anode efficiency came out to be rather high (75.6%) and overall efficiency 70%. It was suspected that the assumed line impedance (365 ohms) was not correct, and it became therefore necessary to measure the peak volts across the line to get a better estimate of the output. The line being of the balanced two-wire type, two peak voltmeters in series were used across the line. One voltmeter gave 1.47 Kv. and the other 1.35 Kv. The total peak voltage across the line was thus 2.8 Kv. The line current was 6.4 A in one arm and 7.2 A in the other, giving an average of 6.8 A. This gave the actual output as 13.6 Kw. and a line impedance of 300 ohms roughly.

The H.T. used was 9 Kv. and it was suspected that the system may not be stable at higher voltages during modulation because the exciter for an inverted amplifier has also to be modulated simultaneously with the output stage. To check this, modulation tests were made and the distortion produced was also measured. The distortion at 75% modulation indicated the stability during modulation. The amplifier valves being tetrodes higher percentages of modulation could not be secured easily by modulating the anodes only.

Stability tests on 30 metres:— The grid, anode and line circuits were next adjusted for 30 metres. Self oscillations occurred with four valves and an output of 20 Kw. was obtained. Two valves were taken out and the circuits tuned again—self oscillation still persisted. Two 2000 ohms resistances were next connected in series between grid-to-grid to provide grid damping and the system was found to be stable with two valves. It is important to note that for stability tests under actual working conditions some resistance between grid-to-grid must be used because, when driven properly, the grids consume power from the grid tuned circuit and provide the damping. When testing stability without drive, this damping should be provided by some extra resistance.

It was anticipated that when the valves will be "driven", the amplifier should be stable without the extra damping resistance. Actual tests proved the validity of the anticipation. Calculations and measurements showed that the total power consumed from the grid tuned circuit was 500 watts; the grid-to-grid peak voltage was 1800 volts, giving effective grid damping of 3,240 ohms. This compares favourably with the grid damping resistance $2000 + 2000$ ohms during stability test.

From two valves an output of only 12.8 Kw. was obtained on 30 metres. This being far below the requirement (20 Kw.), stability tests with four valves were therefore continued.

Stability with negative feed back:—The scheme shown in Fig. 9 was adopted. It is obvious that the

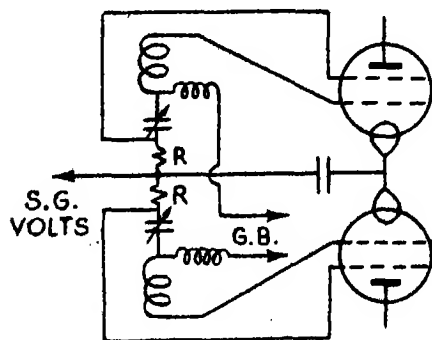


FIG. 9

oscillatory current flowing via the anode-screen grid capacity through R would introduce the necessary negative feed back. The R's were of course non-inductive "Givrite" carbon rod resistances. On 30 metres it was found that a value of 4 ohms for R was sufficient for stabilising four valves. On closer inspection, however, it was found that this type of feed-back would necessitate a tremendous loss of energy. The anode-screen grid capacity of the valve being about $30 \mu\text{f}$, it was easily calculated that at 30 metres the loss (H.T. being 9 Kv.) would be about 5 Kw. The idea of such a system of feed-back was therefore given up.

Various values of feed-back resistances up to 400 ohms between centre-to-centre of filaments were next tried. The circuit used for this purpose is really interesting (Fig. 10). The quarter-wave line for filament heating insulates the filaments from h.f. leakage. This was tested by means of a neon lamp whose glow was maximum near the filament end of

the line and zero at the "shorted" end of the $\lambda/4$ line.

There was, however, no sign of any definite improvement. It was then realized that the major portion of the inter-electrode h.f. current from the anode tank circuit flowed via the anode-screen grid capacity and therefore very little in the cathode circuit. This was why the filament-to-filament feed-back resistance produced no effect.

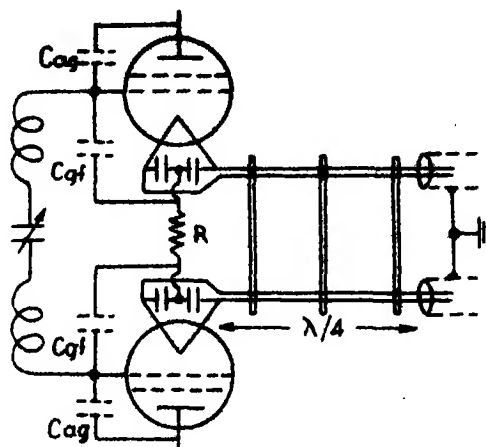


FIG. 10

The Inverted Amplifier:—All normal straightforward means for stabilising having failed it was next decided to try "Inversion". In this the grid is tied to ground and the filament is at r.f. potential. The filament heating current was supplied via the quarter-wave network as described above and the input rearranged according to the new requirements. The system was found quite stable on fundamental but there was very strong parasitic oscillation which latter was easily suppressed by introducing further damping resistance across grid "leads".

Further tests on the Inverted amplifier were discontinued specially because this stage was intended to drive a 200 Kw. stage which latter would be inverted. As it is very much complicated to manage two consecutive inverted stages it was decided to make further attempts for securing stability under normal amplifier conditions.

Neutralizing Power Tetrodes:—The difficulty in neutralizing tetrodes will be appreciated if we bear in mind the fact that in the usual bridge type of neutralization of a push-pull amplifier, the value of each neutralizing condenser is the same as that of the anode-control grid capacity. In the case of

tetrodes this capacity is extremely small, (0.6 μf in the present case), and it needs no emphasis that in high power circuits where components of large size are used, the reactance of the leads makes it extremely difficult, if not impossible, to adjust neutralizing condensers of such small values. Neutralization was carefully tried, bearing all these points in view, but oscillations could not be controlled in any way.

It is unfortunate to record that the present European War broke out at this stage and further work in this line had to be discontinued.

IONOSPHERIC RESEARCH IN ENGLAND

The ionized regions of the upper atmosphere which are responsible for guiding radio waves over long distances are collectively known as the Ionosphere. It has now been established that the ionosphere has several layers of maximum ionization; recently the existence of definite ionized layers in the lower atmosphere has been proved by observations made at Calcutta and has been verified by other workers abroad.

The study of the ionosphere is of very great importance both from the practical as also from the theoretical point of view. The tendency in recent years has been to use short waves for long distance communication because of their many advantages. The propagation of the short waves being dependent on conditions of the ionosphere, it is obvious that a knowledge of the nature and the variations of this connecting link between transmitter and receiver is extremely important to the practical radio engineer. The choice, for instance, of the optimum wavelength of transmission between any two places depends on ionospheric conditions, with the time of the day and the season of the year. A detailed study of these and various other associated subjects is thus very necessary for maintenance and development of radio communication systems between widely separated countries.

Further, the source of ionization in the upper atmosphere, the causes of its temporal and other erratic variations are of profound scientific interest and have attracted the attention of investigators of various countries. Work in this line in India was started first in Calcutta in 1930 and is now being carried on at some other Universities and Institutions also.

The principal centres of ionospheric investigations in England are the National Physical Laboratory, the Marconi Research Department, Cavendish Laboratory and Imperial College of Science and Technology. The British Post Office and the B. B. C. also take great interest in these works but do not carry out directly any researches. They utilise, so far as the development of their communication systems is concerned, the results of observations made by other establishments.

The *National Physical Laboratory* maintains a Radio Research Station at Slough, about 20 miles from London. Dr. R. L. Smith Rose is the Superintendent of the Radio Division of the National Physical Laboratory which includes the Slough Station. The locality being rural and the Station having large open fields, it is eminently suitable for field work. Amongst the ionospheric works carried on here mention may be made of the following:—

(i) *Automatic recording of the variation of equivalent height.* A system of automatically recording the variation of equivalent height (P') of the ionospheric layer (or layers) with time or with the frequency of the exploring radio waves has been developed. The tuning arrangements at the transmitter and receiver are electrically linked in such a way that the oscillator frequency of the superheterodyne receiver is automatically maintained at the correct level above the transmitter frequency throughout the tuning range. Routine observations of these so-called (P' -t) and (P' -f) curves are made daily with vertically incident waves. Vertical rhombic aerials are being used both for transmission and reception, the peak output of the transmitter being about 0.5 Kw.

(ii) *Direction finding on short waves.* Some time ago a longer-short wave (30 to 70 m.) direction finding equipment, using spaced aerials of the Adcock type, was developed at the station. Very recently special short wave (down to about 5 metres) super-heterodyne receivers have been developed which permit of very careful matching. A cathode ray oscillograph (high vacuum type) is used as the visual and direct indicator. The system can also be used for aural reception.

(iii) *Polarization of radio waves.* A cathode ray comparator was first developed for this purpose. Recently the equipment has been modified for studying the polarization of short-duration pulses of radio waves.

(iv) *Measurement of the angle of incidence of downcoming waves.* In designing short wave antenna systems for long distance transmission it is extremely important to know this angle. The cathode ray comparator is very suitable for this work and is being so used at Slough in conjunction with two horizontal aerials spaced a known distance apart.

(v) *Development of a new time-base circuit.* In many ionospheric investigations a high speed of the cathode ray spot on the screen is desirable for greater resolution. For this purpose a novel time base circuit is being developed at Slough. The time base period remains $1/50$ second, which is convenient for the purpose of synchronization with the A.C. mains frequency, but during this period the motion of the spot is made discontinuous and may be said to consist of three parts. The spot moves very rapidly from the beginning to the end of the sweep, remains steady for some time and then sweeps back to its initial position. The time for the first part of the motion may be controlled and made a small fraction of the total period to obtain greater resolution.

The Marconi Research Department also maintains a section for ionospheric research under the guidance of Mr T. L. Eckersley, F.R.S. The maintenance of such a section by a purely commercial organization is in itself a proof of the great practical importance of such investigations. The Research Department was shifted early in 1939 from Chelmsford to Baddow, a few miles west of Chelmsford. The site at Baddow is also clear and level and the open fields are most favourable for ionospheric field work. The pulse transmitter for these investigations is still at the Marconi Works at Chelmsford. The Department also maintains a Receiving station at Broomfield about a mile to the east of Chelmsford.

At Broomfield regular routine observations of (P' -f) curves are taken. The wavelength of the transmitter at Chelmsford is controlled from Broomfield by means of special telephone lines reserved for this purpose. About 10 minutes are required for a complete (P' -f) curve for the Region F and usually three observers are required at the receiver and one at the transmitter.

Investigations on the scattering of wireless waves in the ionosphere are also carried on partly at Broomfield. These are done mainly with special high-power (40 Kw) pulse transmissions from the Marconi Beam Station at Ongar, 12 miles from

Broomfield. Observations are also made with omnitransmissions (16 Kw.) from another transmitter at Ongar.

The work at Broomfield consists chiefly of studying the retardation and general nature of the scattered radiation with a cathode ray oscillograph using the normal pulse technique. Observations are made with frequencies both above and below the critical penetration frequency for normal reflection of radio waves from the Region F. The cathode ray equipment at Broomfield which has been lately developed incorporates a time-base of the type being developed at Slough and described above. The mode of operation is, however, entirely different. At Slough the spot movements are controlled by electrostatic forces, while at Broomfield this is done by magnetic forces with the help of a pair of coils.

The pulse transmitter at Chelmsford consists of a push-pull balanced oscillator with series modulation. The radiating system is composed of four vertical rhombic aerials fed in phase. The termination of each rhombic (1,000 ohms) is shunted by a coil of suitable magnitude, whereby on long waves the rhombic is equivalent to an ordinary loop aerial. On short waves, however, the impedance of this coil is large and the termination makes it a real rhombic.

The main ionospheric investigations carried on at Baddow are:—

(i) *Polarization of downcoming waves.* A pair of loop aerials fixed at right angles to each other and rotatable round a common vertical support are connected by slip rings to the field coils of a radiogoniometer. Each loop is detuned from resonance, one 45° forward and the other 45° backward. By rotating the loops so that their planes are along the axes of the polarization ellipse (as projected on the surface of the earth) and by setting the search coil at an angle whose tangent is the ratio of these axes, a zero can be found. By using the pulse method the ordinary and extraordinary components may be separated and each studied separately.

Some very interesting experiments are being made for determining the limiting polarization of medium waves reflected from the Region E, the main object being to decide whether the polarization term in the magneto-ionic formula should be retained or not.

(ii) *Direction finding by means of spaced frame aerials.* Two aperiodic frames are located 20 metres

apart and are fed by twin-wire screened cables to a central unit in the receiving hut. The relative input phases of the signals from the two frames can be changed and measured and the relative input amplitudes can also be altered so as to balance the inputs to the two matched receivers. The outputs from these are, as usual, applied to the deflecting plates of a cathode ray oscillograph. The phase and amplitude adjustments necessary in the central unit to get a linear 45° trace on the oscillograph screen, gives the relative phase and amplitude of the signals induced in the two frames.

The spaced frames are also used to measure the angle of inclination of downcoming waves from the ionosphere.

(iii) *Direction finding by spaced vertical aerials of the Adcock type.* The operation is practically the same as that used at Slough. Incidentally it may be mentioned that the spaced frame aerial type of direction finder has been found to give better results.

(iv) *Scattering of radio waves.* A long series of experiments is being carried on for the last few years on this subject. The direction, apparent equivalent heights of reflection, polarization and such other characteristics of the scattered radiation have been studied thoroughly with both directional and omni-transmitters. It has been definitely proved that the scattering always occurs in Region E. In the case of beam transmission there are two definite scattering centres. These are located where the beam strikes Region E, first when going up penetrating this region and secondly when coming down (after being reflected from Region F).

Ionospheric Work at Cambridge is being carried on at the Cavendish Field Laboratory by Mr. Ratcliffe and his co-workers. Part of the equipments, specially the transmitters, is located in the grounds of the Solar Physics Observatory and part in the neighbouring grounds of the old Rifle Range. The researches received a strong impetus when Prof. Appleton was appointed Jacksonian Professor of Natural Philosophy at Cambridge University in 1936. Early in 1939, however, Prof. Appleton had to leave Cambridge on his being appointed Secretary to the Committee of the Privy Council for Scientific and Industrial Research.

A series of important experimental works on the polarization of radio waves returned from the ionosphere and on the reflection coefficients of

ionospheric regions have been carried out at Cambridge. Several interesting developments in the technique of such measurements have also been made.

During the author's visit some regular observations on long wave propagation through the ionosphere were being carried on. Already a number of interesting results have been obtained regarding the reflection height, polarization and intensities of the downcoming waves and their changes due to magnetic storms, sunspots, aurorae and such other disturbing causes of the ionosphere.

Recently some experiments are being carried on to measure the velocity of wireless waves over the earth's surface. The underlying principle is an adaptation of the pulse technique for ionospheric investigations. A pair of pulse transmitters and receivers are set up at some distance from each other. The pulses sent out from one transmitter are received at the second station which is thereby made to radiate pulses instantaneously. The time interval between pulse emission at the first station and the reception of the back pulse from the second is measured on a cathode ray oscillograph and the velocity of the waves calculated therefrom. It may be noted in this connection that the Cambridge measurements give, for the waves travelling along the ground, a velocity equal to that of light, whereas similar measurements previously made in U.S.A. gave velocities sometimes as low as half that of light.

At Cambridge an apparatus, called the Electric Differentiator, has been developed with which the order of accuracy of height measurement is claimed to be 0.5 Km. This apparatus has been used to study the variation of equivalent height of Region E with solar altitude. The same apparatus is being utilized for detecting the presence, if any, of atmospheric oscillations in Region E due to lunar tides. Some important results have been obtained and the observations are being continued.

The pulse transmitters at Cambridge are grid modulated in contrast with the series modulation system at Slough and Chelmsford. The transmitting aerial is, however, of the vertical rhombic type as is used at Slough and Chelmsford.

At the Imperial College of Science and Technology, London, various theoretical investigations connected with the ionosphere are being carried on by Prof. S. Chapman and his co-workers. It may be recalled that the first theory of the nature of

formation of an ionized layer in the upper atmosphere by absorption of monochromatic solar radiation was given by Chapman. Very recently he has remodelled this theory on the basis of band absorption. Problems of upper atmospheric oscillations, of variations of upper atmospheric ionization due to sunspots and due to charged and uncharged particles emanating from the sun and their correlation with terrestrial magnetic variations are also being investigated in great detail. At the time of the author's visit Prof. Chapman was engaged in completing his book on 'Geomagnetism'.

CONCLUSION

It is futile to compare the conditions regarding teaching, research and industrial development of radio in this country with those of a highly industrialized and wealthy country like England. Nevertheless it is the opinion of the author that even in the existing conditions in this country, a great deal of improvement can be made with a little more of effort and determination. Much advance in research is possible if there be co-operation between the universities on the one hand and the Government departments on the other. With more financial help from the Government and the university, the teaching of Radio could be remodelled for imparting to the students a thorough knowledge of its theory and practice. There is, of course, the difficulty in the absence of industries, to provide, at present, for that special type of training which only a close co-operation between the industries on the one hand and the teaching institutions on the other can afford. Nevertheless, we would only be moving in a vicious circle if we allow ourselves to be deterred by this difficulty. On the contrary, improvement and advancement in teaching and research will have a stimulating effect on the radio industry which is bound to develop with the industrialization of the

country in the wake of the war. Men and money are of course needed for the purpose. But in the opinion of the author any increased expenditure on this head will be amply repaid because our trained students will render indispensable help to the growing industries.

In conclusion the author would like to draw the attention of the readers to some of the important features of the teaching institutions as also of the manufacturing concerns which impressed him most.

In the teaching institutions, the most important thing which he observed was the close association which the institutions maintained with the manufacturing organizations. He further found that great importance was attached to frequent meetings of the senior students and the staff for discussions of various topics. The research organizations receive help from the industries through the Board of Scientific and Industrial Research. These organizations are invariably run by a highly specialised staff. When a particular problem is to be tackled, the principal research worker plans the mode of attack and distributes the various aspects of the problem to the respective specialists. The result is that no time is wasted over subsidiary investigations. The data are quickly collected and the work is speedily brought to a successful conclusion. In the industries also there is intense specialisation and this, in the opinion of the author, is one of the principal factors for the maintenance of the high quality of British products.

The author would finally like to take the opportunity of thanking all those who gave him facilities for his studies. It would have been impossible for him to visit and stay at so many places within the short time at his disposal but for the kind and courteous help which was accorded to him everywhere.

Limnological Investigation and Improvement of Villages

K. BISWAS

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IN my article on Water-hyacinth published in the *Bengal Weekly* of the 13th March, 1939, I dealt briefly with the life-history of this powerful plant-pest. Attempts were made and are being continued with zeal to remove this pest by manual labour and mechanical means. The methods were first advocated by my revered teacher, the late Prof. P. Brühl about 20 years ago, after having carried out prolonged experiments on this plant and on the different chemicals supposed to be capable of killing the plant. Following Professor Brühl, Griffith, Parija and others carried on investigations. The present author as a result of his studies has arrived at the same conclusion as that of Brühl in regard to the method of eradicating this pest. In his several articles he has emphasised the adopting of mechanised methods and more organised labour to fight successfully for the total extermination of this plant. This enemy of ours belonging to the plant kingdom invaded Bengal first, and by its rapid vegetative growth spread like wild fire all over the water expanses of this and the adjacent provinces during the last quarter of a century. The eradication of the pest has thus become a complicated problem and a gigantic task and it is baffling the attempts of the scientists, the State authorities and the public at large for a fairly long time.

It is indeed gratifying that during the last water-hyacinth campaign by the Bengal Government sufficient public interest has been aroused in the matter of eradication of this pest. The cultivators have realised the great economic loss this pest is causing by encroaching on their rice-fields and waterways. Water-hyacinth is now interfering with the progress of irrigation, cultivation, public health, sanitation, pisciculture and water supply in the villages, particularly in the eastern and lower parts of Bengal. It is expected that by more efficient organisation and with the help of suitable machinery an unceasing war

will be carried on against this pest, particularly in the affected villages from the beginning of the autumn to the end of the hot season year after year. This task will require the co-operation of the district officers and the rural reconstruction department and should have the solid support not only of our Ministers but also of our public leaders.

There is another set of aquatic vegetation in addition to this pest. Anyone, even a casual rambler, walking along the side of a lake, a jhil, a tank, a pond, or a puddle, and observing plants and animals floating, swaying, dancing and playing in the water in their natural beauty, cannot but wonder at the marvels of pond-life, and will find in them "complete expression of the will of God in things created". This is good for a biologist and a philosopher but if we look from the standpoint of human welfare, the problem of tackling the dense masses of water plants, which often choke up the various types of water in this province, demands, by no means, less serious thought for their control. In the present article, reference has been made to some of the common aquatic plant communities of our tanks, jhils, lakes, ponds and puddles and to the part they play in the economic life of this province. The study of our aquatic vegetation is of considerable importance in tackling the problem of irrigation, pisciculture, sanitation, public health and of provision of good drinking water in our villages.

In a water reservoir, where aquatic plants are allowed to have free play, one finds, other than the vital layer (the bottom layer of fine muddy silt with minute bacteria, algae and lower animals) and zone of rooted aquatics, another zone of submerged plants which generally float in suspension under water. Of such plants the most common species of our country are *Hydrilla verticillata*, *Ceratophyllum demersum*, *Myriophyllum tuberculatum*, *Lagarosiphon Roxburghii*, *Najas indica*, *N. foveolata* and the

insectivorous bladderwords—*Utricularia flexuosa*, *U. stellaris* and others. These submerged suspended aquatic plants in old lakes, tanks, etc., often develop an impenetrable network of dense vegetation in the central column of water. Some of these plants, e.g., *Utricularias*, prefer to occupy the surface layer of water. These plants, like other water plants, propagate more rapidly by vegetative method of reproduction than by sexual method, that is, by seeds which on maturing drop on the mud and germinate. These plants growing from seeds are at first attached to the mud during the juvenile stages of growth, but later on they dislodge themselves from the loose muddy layer and float freely in suspension under water. The fruits of *Ceratophyllum demersum* are, like those of *Trapa bispinosa* and *T. natans* (Panifal), furnished with three spinules at the three corners. When they fall in the mud, they stick on to the soil and are not easily shifted by the movement of the water below. During January and February and sometimes in March too, these plants flower and fruit, and the seeds are available from July to September and October. During the cold season, *Utricularias*, *Hydrilla verticillata*, *Ceratophyllum demersum* and other submerged aquatic plants develop vegetatively by another kind of winter buds known as "hibernacula" or "squamulae intravaginales", which also grow out into new plants, thus tiding over the unfavourable season. These plants depend for their growth mostly upon the nutrient salts dissolved in the water. But their occurrence in the middle zone deprive the rooted water plants below much of their light and oxygen. The floating submerged aquatics harbour many epiphytic algae, especially *Conjugatae*, (*Desmids*), *Oedogoniales*, *Ulotrichales*, *Diatoms*, *Charecium* and colonial members of *Chlorococcales*, such as species of *Scenedesmus*, *Pediastrum*, *Coelastrum*, *Ankistrodesmus*, *Oocystis*, species of blue-green algae of the family of *Chroococaceae*, *Chamaesiphonaceae*, *Oscillatoriaceae*, *Rivulariaceae*, *Scytonemataceae* and others.

The suspended mass of vegetation gradually leads to a denser surface vegetation, partly due to the stagnation of the water and partly to the supply of rich plant food in the form of dissolved salts. The conversion of rotten vegetation and other organic matters into nutrient salts is entirely due to the activity of the putrefying bacteria and schizomycetes of the vital layer at the bottom, where older portions of the vegetation and other organic matters continuously settle down. There is thus a cycle of biological actions and reactions by which the lakes,

tanks and ponds are supplied with an inexhaustible store of food materials for the growth of plants. In such tanks there is frequently met with not only a rich macro-phyto-plankton (macro-plankton is composed of a plankton flora whose members are visible to the naked eye) but also amphibious plants. By amphibious plants here are meant marsh plants or those terrestrial plants which grow on moist soils along the edges of tanks and adapt themselves easily to aquatic conditions. The macro-phyto-plankton of our country is mainly composed of the representatives of the family of *Lemnaceae*, of which *Wolffia arrhiza* is a very minute gregarious plant floating in water as green granules. Of similar habit is *Lemna polvrrhiza*, *L. paucicostata* and *L. trisulca*, which are characterised by their small, round or oval flat leaf-like modified shoots. The aracious *Pistia Stratiotes* and Pontederiacious *Eichhornia speciosa* (the water-hyacinth) are larger members of the Phanerogamic macro-plankton flora. The others belong to *Hydropterideae* (the water-ferns), of which the rootless *Salvinia natans*, *S. cucullata*, the Brazilian *S. auriculata* and *Azolla pinnata* are quite common everywhere. The largest fern associated with dense growth of aquatic macro-plankton flora is *Ceratopteris thalictroides*.

The micro-phyto-plankton of this warm country is not fundamentally different from those of the other warmer parts of the world. Of the representatives of the micro-phyto-plankton, the blue-green alga *Clathrocystis aeruginosa* is the most dominant species found all over the Indian Empire in lakes, tanks, pools and other water reservoirs floating in great abundance as minute blue-green granules. This alga is not infrequently mixed up with other plankton species of *Cyanophyceae*, such as *Microcystis flosaquae*, *Anabaena flosaquae*, *A. indica*, *Spirulina major*, *S. platensis*. Associated with these are sometimes found mucous nodules of *Gloetrichia pismus* and *G. natans*. These members of *Nostocaceae* are at first attached but later on found floating. The green algae, such as *Volvox Aureus*, *Pandorina morum*, *Gonium pectorale*, *Chlorella vulgaris*, and zoospores of *Ulotrichales* floating in enormous numbers form either pure or mixed association. *Diatoms*: *Synedra affinis*, and its var. *fasciculata*, *S. ulna*, *Melosira* sp., *Fragilaria* sp., *Nitzschia* sp., and others; *Desmids*: *Cosmarium* species, *Closterium* species, *Euastrum* species, *Xanthidium* species, *Staurastrum* species; *Scenedesmus*: *Scenedesmus quadricauda*, *S. prismticus* *S. brasiliensis*, *S. obtusus*, *S. acuminatus*; *Pediastrum*: *Pediastrum tetras*, *P.*

duplex, and its var. *clathratum*; *Coelstrum cambri-cum*; *Ankistrodismus falcatus* and others, are the common constituents of micro-plankton flora. Both the unicellular and colonial members of the micro-phyto-plankton exhibit various peculiar adaptations for the purpose of floatation, locomotion and absorption of food materials. Mixed with these green algae are also found ciliated representatives of unicellular green algae Dinoflagellata. Of the Flagellates, Euglena is the most common in the lakes, tanks, and particularly in smaller pools and puddles where the water is rich in organic matter. Due to the variation in intensity of light the Euglenas change their colour from green to brownish red.

The water of the filterbeds is supplied from the pre-settling tanks. These feeding settling tanks of the filterbeds harbour a luxuriant stock of rooted aquatic and submerged vegetation nearly choking up the whole area. This accounts for the rich organic contents of the water of the filterbeds. The growth of the smaller members of micro-phyto-plankton, as found in the filterbeds running for a few days, is interfered with by the development of filamentous algae, such as *Tribonema bombycinum*, *Hydrodictyon reticulatum*, *Cladophora crispata*. These algae at first grow on the beds of sand of the filterbeds, but later on dislodge from the bottom. They then gradually rise to the surface due to the pressure exerted by the bubbles of gas (oxygen produced as a result of photosynthesis) caught up in the plankton or 'tricho-plankton'. Of this 'tricho-plankton' formation, when one dominant species forms more or less pure association, as frequently found in the filterbeds, they are distinguished as a particular association of that species, such as *Tribonema* association or *Tribonemetum*, *Hydrodictyonetum* and *Cladophoretum*. Thus floating in dense masses these filamentous algae finally choke up the entire bed. This condition leads to serious damage of the beds due to fissures caused by the uplift of the algae breaking up the vital layer which is highly beneficial to filtration. The large filamentous algae of 'tricho-plankton' harbour in its turn a huge stock of animal organisms by supplying food and shelter. Among the animal organisms, *Crustacea*, *Mollusca*, worms (Nematodes) etc., burrow holes in the beds of the filterbeds which destroy the vital layer and seriously interfere with the action of filtration. Further their excrements and respiration disturb the biological balance of the water of the filterbeds by inhibiting the self-purificatory action of the micro-phyto-plankton. The favourable action

of the micro-organisms of the vital layer of the filterbeds, and consequently the action of filtration is in this way considerably checked.

In stagnant lakes, ponds, etc., which harbour a rich submerged and surface vegetation, the biological conditions of the water like those of choked-up filterbeds are also entirely upset. The submerged vegetation under the screen of a dense surface vegetation gradually dies in the absence of light and oxygen. They then settle down and rot at the bottom. The rooted members of the aquatic plants beneath, after mouldering to death under the double roof of surface and suspended vegetation, gradually decompose. The micro-plankton, and in some cases the smaller members of macro-plankton flora, are eliminated at the very outset, as they are unable to cope with the rapid growth of the larger members of mega-plankton flora and amphibious plants forming the surface vegetation. The water of such tanks and pools, thus devoid of light and oxygen, becomes surcharged with the excess of humic acid, carbonic acid and other injurious productions of putrefaction bacteria, such as ammonia, sulphuretted hydrogen, acetic acid, peptone and other various compounds of complicated structure. The colour of the water of such tanks, ponds, etc., appears dark brown due to rich humus contents. Such unhealthy condition of water is detrimental to all freshwater fauna, not to speak of human beings and consequently the edible fauna with others soon disappear for want of food materials in the form of lower members of the animal kingdom, such as *Cyclops*, *Copepods*, *Rotifers*, *Paramecium*, *Amoeba* and various others living on the micro-phyto-plankton. Their absence in such foul water is partly due to want of oxygen, illumination and sanitation and partly to abundance of poisonous elements prevailing in such unhealthy waters. The prevalence of fish mortality in jhils, tanks, ponds, etc., in this country causes great economic loss. This phenomenon generally takes place during the hot days before the advent of the monsoon. The cause of such fish mortality may perhaps be partly ascribed to the upsetting of the biological balance by the aquatic vegetation in a jhil, tank or pond.

These biological causes thus lead not only to unhealthy state of water in tanks, jhils, ponds and puddles in our villages but sometimes choke them up completely. Such a state of affairs produces considerable scarcity of drinking water in the villages. Bengal is drained by a number of rivers and waterways but in spite of this there is so much scarcity

of water. The unhealthy state of water due to vegetable growth also raises a fundamental difficulty in maintaining public health, particularly in regards to epidemics of malaria. The life history of parasite-carrying mosquitoes, in larval stage, is intimately associated with the aquatic vegetation of the country and it should be of special interest for the malarialogists to study these aquatic plant communities to ascertain the distribution of these mosquitoes.

The great energy of the micro-phyto-plankton, and the micro-organisms at the bottom, absorbing and utilising in various ways the diverse kinds of organic substances resulting in maintaining a biological balance in water, is generally spoken of as the "self-purifying" action of water. For the maintenance of the balance of self-purificatory action of water it is obvious that the lakes, tanks, ponds, etc., must be devoid of surface vegetation, macro-plankton flora and suspended submerged vegetation. The rooted plants utilising the nutrients from the mud should be allowed to grow to a certain limit, as their existence is favourable to the development of micro-phyto-plankton. The micro-phyto-plankton is the chief source of food for *Rotifers* and *Crustaceas*, which in their turn serve as food to smaller aquatic animals. These are again devoured by larger fishes which finally form an important diet of human beings.

In these days, when there is a cry everywhere for economic return of scientific undertakings, and as the value of the results of scientific investigations and discoveries is sometimes estimated in rupees, annas and pies, I may be permitted to emphasise the

great commercial importance of pisciculture in this country and particularly in Bengal. In Bengal there is an enormous field for scientific cultivation of fishes which might result in an inestimable money value. As some of the fishes feed on mosquito larvae, fish cultivation is useful for anti-malarialogical work too. Scientific pisciculture leads to biological investigation. In Europe and America it has attained a very high stage of advancement. In our country we are still hesitating to take up such investigation and speculating about its profit and loss. Proper limnological researches require a team work of biologists, chemists and physicists—the latter to study the plant food in the form of nutrient salts dissolved in the water, physico-chemical changes under diverse conditions at different times of the year and so on. Investigations of the relation between plant and animal life, their periodicity and life-history and similar other problems should be tackled by biologists. Our rivers hold potential treasures in the various kinds of edible fauna. Some of the most favourite fishes, such as *Hilsa*, *Velki*, and others pass a particularly important period of their life-history in these rivers. The rivers and streams also act as great migratory agents, and the biologists have to reveal the secrets of distribution of the flora and fauna and control their migration in our lakes, jhils, tanks, ponds, etc. The economic salvation of the country can therefore be partly attained by developing this enormous wealth of vegetable and animal resources of our land and water by modern scientific methods. We should therefore spare no pains to undertake and sustain researches in the field of biology.

Telescope Making at Home

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(Continued from the last issue)

DIFFERENT TYPES OF TELESCOPE

SO far we have described how a small telescopic mirror of general type can be prepared and tested by the simple equipments at home. Larger mirrors, 18 or 20 inches, can also be made in a similar way but greater difficulties are encountered in course of the process. Larger mirrors are more powerful, and the power increases more rapidly with its diameter. The mirror-surface increases proportionally to the square of its diameter and much intensity is thus obtained. It enables the telescope to produce higher magnification without impairing the bright view.

Besides grinding larger and larger mirrors, amateurs will find it interesting to attempt different types. A few of these used for different purposes are described below :

R. F. T. : Amateur telescope-makers who have gained some experience in the technique of grinding and testing general types of mirrors may proceed to prepare a short-focus for making a Richey Field Telescope or the R. F. T. Not only it has to be scooped too hollow which is a hard labour, but the testing and parabolizing will also be a difficult task. Such mirrors have short focal length near about $F/4$. This gives a short tube length making it a handy instrument. R. F. T. is used with eye-pieces giving nearly 20 magnification showing an angular field of view of about 2° . As the short focus mirrors have high light-gathering power they show up wonderfully sparkling image.

Long-focus Mirror : The long-focus objective making should be taken up by a person who has gathered experience in astronomical studies. He may become a sort of professional astronomer in the sense that he may utilize this type for a specific type of astronomical observation. Such long-focus objectives are specially suited for photographing the solar features in general and the eclipse, in particular.

There are very few amateurs who have prepared a solar mirror. The size of the solar image is given by $S = 0.0093F$, where, S denotes the image diameter, and F the focal length of the objective. Thus in order to get an image of 2 inches in diameter, the objective should have a focal length of about 18 feet.

Clyde Tombough who discovered the planet Pluto, prepared a 12-inch $F/12.3$ solar mirror with plate glass, and used it unsilvered. This gave 1.4 inch image size of the sun. With 200 astronomical magnification the details of sun-spots, grains and faculae were clearly visible. The biggest Solar Tower at Mt. Wilson consists of 60 ft. focus, 24-inch mirror ($F/30$), giving a solar image of 6.7-inch in diameter.

Cassegrainian Mirror : For many of the amateurs considerable interest will lie in making Cassegrainian mirror with short focus and perforated at the centre. This gives short tube-length, direct vision and high magnification. The mirror is usually about $F/4$ and perforated with a hole about $1/5$ the diameter of the disc. The auxiliary convex mirror which is of the size of the perforation, has its focal length depending upon the resultant focal length required of the system. Obviously enough, the shorter the focal length of the convex, the longer is the focus of the combination. But usually the convex has focal length of about $1/4$ or $1/5$ that of the primary concave. The convex mirror for the Cassegrainian combination may be conveniently made from a spectacle lens of suitable power (curvature), silvered at one face by the Brashear's process described early.

The perforation is generally done after the mirror has been prepared. A 6-inch Cass may be perforated with 1 or $1\frac{1}{4}$ -inch hole. It is done by a copper or brass tube of the same external diameter, driven by an electric drill and fed with carborundum powder. No. 120 carborundum should be used first, and when some depth has been obtained, coarser

grade may be used to get quick cutting action. But towards the end, No. 120 must be reverted to in order to avoid the risk of chipping. Gentle pressure and low revolution (about 200 r. p. m.) of the drill should be used. One inch plate will take about $1\frac{1}{2}$ hour to perforate through. The first surface drills cleaner than the succeeding where chipping is more likely to take place. It is therefore advisable to begin the drilling from the optical surface taking sufficient care not to scratch it with abrasive. A

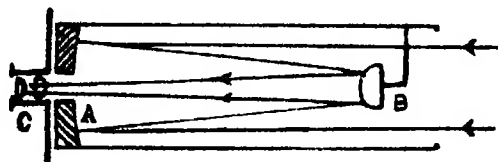


FIG. 9.
Cassegrainian Telescope. A. Perforated concave mirror. B. Secondary convex mirror. C. Eyepiece.

coating of lacquer-varnish may be painted over the surface to give a protection. When the drilling is complete, the coat may be peeled off and washed with ordinary methylated spirit which is its solvent.

The $F/4$ Cassegrainian primary may also be used very well as an R. F. T. in the usual Newtonian form, and both the features may be retained in the tube. Such a double featured mounting gets the abbreviated name "Newt-cass".

Off-axis Mirror: A new technique has been evolved to eliminate the small diagonal mirror in a Newtonian telescope. The diagonal stops a small fraction of light; but that is not why it is to be avoided. The obstruction presents itself as a source of diffraction centres, and that impairs the quality of the image. In spite of its perfect achromatism and high light-gathering power, it forms an image which is somewhat inferior in optical quality as compared with that formed by a refractor.

This was experimented upon by W. H. Pickering, who stopped the mouth of a reflecting telescope with a diaphragm having a small circular aperture on one side of the axis. The light passing down the tube did not therefore run across the diagonal which was on the axis of the mirror. In this experiment it was found that although the illumination was heavily cut down, the quality of the image improved. Thus one can cut a parabolic mirror into halves (rather a little smaller) and use the diagonal just outside the path of incoming rays. But it will be painful for the grinder to cut his large

mirror into small ones. It is however possible to give a small mirror a sort of tilted curvature so as to drive the optical or geometrical axis of the parabolic mirror outside the mirror itself. In fact, such off-axis mirrors are existing, and experienced amateurs are taking interest in preparing such mirrors. There is however no definite method which may be prescribed for making an off-axis mirror. It depends entirely on the experience and sense of feel of the worker. The testing is also a difficult problem here.

LARGE MIRRORS

Larger mirrors are more prone to catch local defects. What is more primary, the weight of the disc and the force of drag will land the worker in serious complications. The danger of vacuum seizure of the mirror with the tool will increase in the same way. It should be remembered that larger diameter will necessitate thicker disc, otherwise defect of curvature,—specially due to sag and temperature effect,—will come in. Usually, one should not attempt mirrors larger than 10 inch with 1-inch thick plate, although it is customary to keep $\frac{3}{8}$ to $\frac{1}{2}$ as the ratio of the thickness to the diameter of the disc.

But if sufficient care is taken, thinner plates may serve quite all right. The 12 inch $F/12.3$ solar mirror referred to in connection with long-focus mirrors was made out of $1\frac{1}{8}$ inch plate. The ratio of thickness to diameter is $1/10.7$. The author has seen 10-inch optical flat made from $\frac{3}{4}$ inch plate, giving the ratio $1/13.3$. But it is always better to get thick ones for the telescopic mirrors.

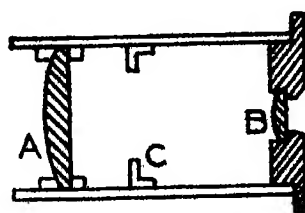
Taking density of glass to be 0.097 lb. per cu. in., a 12 in. \times 2 in. disc. will weigh 22 lbs., 16 \times 2-disc about 49 lbs. and 20 \times 2 $\frac{1}{2}$ -disc about 80 lbs. But large mirrors are not made out of solid discs; they are usually honeycombed at the back. This makes the mirror light yet strong, and facilitates equalization of heat in the changing temperature during grinding and during observation.

So far an amateur has worked up a 21-inch Pyrex completely by hand. It is about $3\frac{1}{2}$ -inch thick and weighs about 100 lbs.

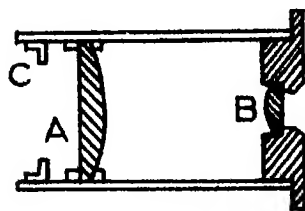
EYE-PIECE

A mirror and an eye-piece make a telescope optically complete. The astronomical magnification

is given by the ratio of the focal length of objective to that of eye-piece. A $\frac{1}{2}$ -inch eye-piece will give a magnification of 100 when used with a 50-inch focus objective. The choice of eye-piece depends chiefly upon the magnification desired. For a 6-inch mirror, magnification up to 50 may be called 'low', 50-100 'medium', and above 100 as 'high' magnifications. For low and medium magnifications, Huygenian or Ramsden eye-pieces are quite suitable. But for higher powers some kind of achromatic eye-piece should be used. Among achromatic varieties the 'orthoscopic' (triple cemented field-lens, single eye-lens) is most reputed. It is a great asset for the telescope maker to possess a 7 or 9-mm focus orthoscopic eye-piece for high magnification.



Huygens



Ramsden

FIG. 10.
Two different Eye-pieces.
A. Field lens; B. Eye lens;
C. Field-stop at the plane of image.

As regards making the eye-pieces it is quite within the reach of an amateur to construct the Huygenian and Ramsden types. These do not require achromatic combinations. The same variety (refractive index) of glass is used both for field-lens and eye-lens. Apart from actually grinding them up it may be possible to get small plano-convex lenses, as spare parts of other instruments, suitable for housing them into a small tube to make a Huygenian or a Ramsden eye-piece. One source is the watch-makers' magnifier, but that has rather too long a focus. But the view-finder lenses of small cameras

are often found with suitable focal length, and they may be obtained at cheap rates.

If both the lenses are of equal focus (f), they are suitable for a Ramsden. The lenses are separated by a distance of about $\frac{2}{3}f$, giving the resultant focus $F = \frac{3}{2}f$. The general formula for the resultant focus is given by $F = \frac{ff'}{f + f' + d}$, where f and f' are the focal lengths of the two lenses separated by a distance d . It should be remembered that for convex lenses the d has got the opposite sign. For convenient calculation, we may put f and f' as positive, d negative. Putting for a Ramsden, $f = f'$ and $d = -\frac{2}{3}f$, we get $F = \frac{3}{2}f$. For Huygenian, we have usually $f = 2f'$ and $d = -\frac{3}{4}f' = -\frac{3}{8}f$, so that the resultant $F = \frac{3}{2}f$. Sometimes $f = 3f'$, and $d = -2f' = -\frac{2}{3}f$ (always the distance is half the sum of the two focal lengths, in a Huygenian), giving $F = \frac{3}{2}f$.

In order to grind lenses for eye-piece a $\frac{1}{10}$ or $\frac{1}{8}$ h.p. electric motor is necessary. The diameter of field-lens is generally less than an inch, while that of the eye-lens is only about $\frac{1}{2}$ of an inch. If a good piece of glass (such as a microscope slide, or a zero-power flat spectacle glass) is used, only one surface has got to be worked up convex by means of a brass or iron 'tool' according to the calculated curvature. For a plano-convex, the focal length will be given by $1/f = (\mu - 1)/r$, where f = focal length of the lens, μ = refractive index of the specimen of glass, and r = radius of curvature of the convex surface. Taking $\mu = 1.5$ roughly, $f = 2r$; we have therefore a general rule that the focal length of a plano-convex lens of crown glass is equal to its diameter of curvature. It is however found that ordinary crown glass has μ between 1.51 to 1.52, so that the simple rule includes an error of 2 to 4 per cent. for the focal length on the shorter side.

To begin with, the glass is cut into octagonal blank and held at the end of the motor spindle by means of resin, melted by a spirit lamp. It is however better to use a brass cap about one inch long fixed with a screw to the motor spindle. This will ensure easy manipulation with the lens. The speed of the spindle may lie between 500 and 1000 r.p.m. A separate spindle mount, with belt coupling to the motor, will serve better. It will keep the motor safe from water and abrasive. The octagonal glass piece is edged into a circle by holding a bent thin strip of zinc or iron sheet fed with carbo. 80 and water.

It is better to use two sets of grinding tools,—one for roughing and the other for fine grinding. The roughing is begun with the carbo.80 and continued till the required curvature is obtained on the glass. It is then changed over to the next grade No. 120, and then to No. 220. The fine tool is then used, beginning with 220. It is needless to mention that the lens and the tool must be washed up carefully between the change of grades.

The polishing is also carried on the spindle, using rouge on pitch or resin-beeswax (95% + 5%) lap on the face of a small piece of wood. The lap may or may not be channelled into a 'honeycomb'. The surface after polishing should be carefully watched with a good magnifier so that no hazy patch remains. Continuous polishing will clear all such unpolished region. Polishing being over, the housing of the field-lens and eye-lens into a brass tube to make an eye-piece needs no special instruction. A field-stop should be placed at the plane of the image. Provision for dark glass attachment may be made in order to facilitate solar observations.

MOUNTING

We now come to the mechanical side of telescope making. In fact, as experience will show, this is more troublesome than the making of mirror or eye-piece. Although we shall always call a six-inch telescope a 'small' one of its kind, it will nevertheless make quite an unwieldy instrument.

There are two essential forms of mounting—the altazimuth and the equatorial. An altazimuth mounting will give the telescope all possible rotations on a fork and vertical axis (fig. 11). An equatorial mount (figs. 12 and 13) will give, in addition, a provision to follow the apparent travel of the stars in the sky. This makes the axis inclined towards the pole star. This is therefore called the 'polar axis' of the telescope. The other axis of rotation is called the 'declination axis'. The astronomical field of view diminishes with increasing magnifications. Usually a magnification of 50 will show a circular field nearly 1° in angular diameter, $\frac{1}{2}^\circ$ for 100 magnification, and so forth. Such small fields sweeps away within a minute, so that readjustment of the telescope becomes necessary. In an equatorial telescope the polar axis is just turned a little in order to catch up the escaping star.

If the mirror turns out very well and if any serious observation is to be taken with it, the mounting should be made heavy (it usually comes out to be 200 lbs.), perfectly free from shake, and smoothly turning about the axis. The bearings of the axis



FIG. 11.
Altazimuth Mount in Fork and
Vertical Axis.

however need not be on balls; bush-bearing of brass will do. The tube may be made from 24-gauge galvanized iron sheet, with a $\frac{1}{2}$ -inch flange reinforced



FIG. 12.
Seven-inch Newtonian Equatorial Telescope
made by the author. Pillar stand $3\frac{1}{4}$ ft.;
telescope tube length $5\frac{1}{4}$ ft. diameter 10 ins.

at the lower end, so that the mirror holder with similar flange may be clamped on with three small bolt-nuts. When not in use, the mirror case may be easily removed from the telescope and be covered with a cap. This will prolong the life of the silver film. The tube may also be made in square section out of $\frac{1}{2}$ or $\frac{3}{4}$ -inch thick teak wood, as is seen in fig. 13. Such tube will make the fittings and attachments very easy.

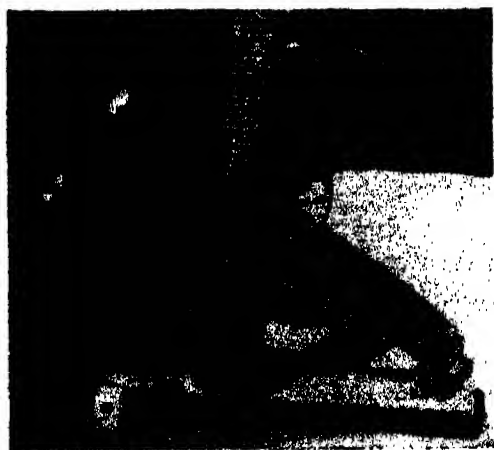


FIG. 13.
Wooden Equatorial Mount.

A properly working worm-and-gear slow drive for the polar axis will make the telescope very useful, but all these details require a substantial assistance of a workshop. Details of mounting cannot be given in the limited space of this article, but a few typical forms shown here will give the reader a general impression. The amateur maker should use his discretion in devising the plan with the facilities available.

HOUSING THE TELESCOPE

Even when the whole thing is complete, the telescope cannot be used profitably unless housed

in a dome of suitable size. This will protect the heavy instrument from sun and rain, and also from the disturbing air draught. A 10-12 ft. dome with about $2\frac{1}{2}$ ft. slit opening will do for a 4-ft. focus telescope. Those who live outside towns and have a small plot of land attached to the house, can build up easily an astronomical observatory and the dome with wooden or bamboo frame-work finally covering it with cheap matting and canvas.

NEED OF AMATEURS' ORGANIZATION IN INDIA

Scientific hobbies not only provide a valuable pastime to the people directly concerned, but they also immensely help the progress of science and industry. They also arouse public interest in science. There have been many valuable systematic as well as chance discoveries made through the hobby-work of amateurs. Scientific studies as hobbies are very much encouraged in other countries where they have been organizing clubs for amateur workers in astronomy, wireless, photography, motoring, gliding, etc. Unfortunately, hobby is not looked upon in this country with the same spirit. The need for arousing public interest in science does not require restressing. Scientific bias in people's mind is necessary for India's industrial development. One way to achieve this is by encouraging the young people who have taken up scientific and technical work as a hobby.

India being near to the equator, she gets an extended view of the southern sky, which is not enjoyed by the United States or England. This opportunity may serve as an initiative for organising an amateur astronomers' association in this country. It appears that this amateur astronomers' association may be conveniently organized through the co-operative agency of the Indian universities.

Recent Advances in Our Knowledge About Certain Enzymatic Reactions in the Living Cell*

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INTRODUCTION

ABOUT two decades ago Willstätter aptly stated that life may be regarded as a system of co-operating enzymatic reactions. Indeed when we consider that all metabolic processes of the living cell concerned in its manifold activities, such as hydrolysis, oxidation, reduction, disintegration, synthesis, etc., depend upon enzymes for their proper execution, we realise the intimate connection between enzymes and that state of existence which we call life. The understanding of the course of events in the living cell, which is the simplest unit of life, in terms of the established concepts of physics and chemistry has been the concern of scientists ever since the time of Lavoisier (1780) who declared "La vie est une fonction chimique". But the chemical transformations brought about by the living cell could hardly be imitated outside it, and it was only fifty years later when Berzelius (1836) introduced the concept of catalysis and Wöhler (1828) synthesized urea that Lavoisier's view could be harmonized. With the isolation of diastase from germinating seeds by Payen and Persoz (1833) the idea and role of enzymes became more firmly established. The early history of enzymes and their function in the living cell is closely associated with the phenomenon of alcoholic fermentation by yeast. The controversy between Liebig and Pasteur (1870) is too well known to be recounted here. Liebig (1839) twenty years earlier had developed a purely chemical theory of enzyme action and he was genuinely pained to see a very important chemical change, namely, the conversion of sugar into alcohol, once again being relegated to the domain of that mysterious vital force from which chemistry had just been rescued by Wöhler's brilliant synthesis of urea. Yet the experimental evidence adduced by Pasteur was too strong to be dismissed so easily as had been earlier in the cases of Schwann, Kützing and others. Liebig was ill at ease and delayed his reply almost for

twelve years. However, soon after, Buchner (1897) obtained a cell-free extract capable of causing fermentation and the problem was solved in a manner satisfactory to both sides.

Buchner's discovery of zymase brings us almost to the modern era of enzyme research. Harden and his co-workers discovered co-enzymes in 1904 and the essential intermediary formation of a phosphoric acid ester of hexose in 1908 for the successful breakdown of sugar in the cell. Neuberg (1911) discovered another enzyme, carboxylase in yeast, which decarboxylates α -keto acids and thus proved the disintegration of pyruvic acid to be a definite stage in the process of fermentation of sugar. These landmarks in the early history of enzymes are summarized in Table I.

TABLE I

LANDMARKS IN THE EARLY HISTORY OF ENZYMES

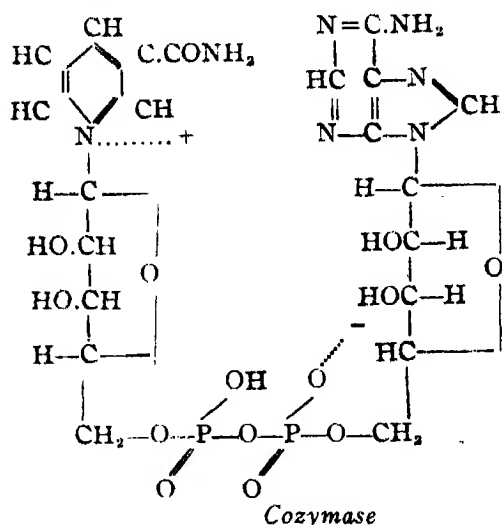
1820	Planche :	Discovered the first enzymes.	
1833	Payen & Persoz :	Isolated diastase from germinating seeds.	
1836	Berzelius :	Described fermentation of sugar as a catalytic process.	
1839	Liebig :	Developed a purely chemical theory of Enzyme action.	
1857	Pasteur :	Demonstrated alcoholic fermentation by living yeast.	
1870	Liebig & Pasteur :	The well-known controversy.	
1897	Buchner :	Prepared a cell-free extract capable of causing fermentation; discovery of zymase.	
1904	Harden & Young :	Discovered co-enzymes; zymase consists of apozymase and co-zymase both of which are necessary for fermentation.	
1908	Harden & Young :	Isolated hexose di-phosphate	} and showed these to be the intermediary products of fermentation.
1914	Harden & Robison :	Isolated hexose monophosphate	
1911	Neuberg :	Discovered carboxylase and showed the disintegration of pyruvic acid to be a stage in the process of fermentation of sugar.	

during the last 4 or 5 years. Though what we actually know is very little, but even at this stage, the importance, the applications and implications of this knowledge are tremendous.

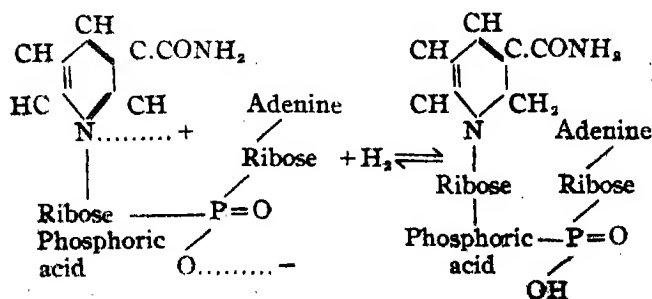
COZYMASE

First of all, let me take the case of cozymase. Cozymase is the prosthetic group of zymase in which it is combined with the protein carrier or tr ager. The first separation of cozymase in 1904 by Harden and Young has already been referred to above. In 1918 Myerhof made the important discovery that the cozymase of yeast also occurred in the muscle and other tissues of animals. Recently Warburg (1936), and Euler and Schlenk (1936) established the chemical composition and constitutional formula of cozymase.

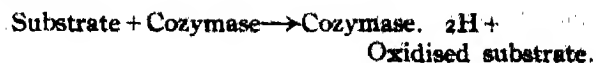
It consists of two molecules of phosphoric acid, two of ribose, one of adenine and one of nicotinic acid amide.



Warburg and Euler have shown that nicotinic acid amide is the active group in the molecule, the nitrogen atom of the pyridine ring being reversibly reduced or oxidised according to the following scheme :



Or briefly :



In alcoholic fermentation and muscle glycolysis the following reactions take place :

1. Glyceraldehyde Phosphate + Cozymase
→ Glyceric acid phosphate + Cozymase. 2H.
2. Cozymase. 2H + Acetaldehyde → Ethyl alcohol + Cozymase.
- or 3. Cozymase. 2H + Pyruvic acid → Lactic acid + Cozymase.

Here thus we have a definite insight into the nature and the function of cozymase in carbohydrate metabolism of the cell. The practical implications of this knowledge will be interesting here.

As already stated the active grouping in cozymase is nicotinic acid amide. The dietetic factor concerned in pellagra was identified to be nicotinic acid in 1937 by Elvehjen and others at the University of Wisconsin. Pellagra, a condition characterised by a severe dermatitis, severe gastro-intestinal disturbances accompanied by mental symptoms has been endemic in many areas, particularly in U. S. A., Egypt, Italy and Rumania. Even in the advanced and relatively prosperous country of U.S.A. pellagra claimed as many as 7,000 victims annually until recent times. Quite a large number of cases continue to be reported from England, Denmark, and other European countries. It was believed that pellagra does not occur in India but during the last few years several cases have come to light. Since the identification of the P.P. factor as nicotinic acid, experimental nicotinic acid deficiency is being intensively studied in the dog, in the pig and the monkey in which a condition akin to pellagra results. With regard to clinical experience with nicotinic acid, I have only to quote the following typical statement by Mathews :—

"The most striking as well as the most gratifying observations in my clinical experience were the rapid healing of lesions from the alimentary tract with the development of an excellent appetite and gastro-intestinal function and the spectacular disappearance of mental symptoms".

More recently 150 cases of an encephalopathic syndrome characterised by clouding of consciousness, cogwheel rigidities of the extremities and uncontrollable grasping and sucking reflexes, are reported from New York which have responded to nicotinic

acid therapy. Hitherto this condition had been almost always fatal. The authors of this report believe that these were cases of more complete nicotinic acid deficiency.

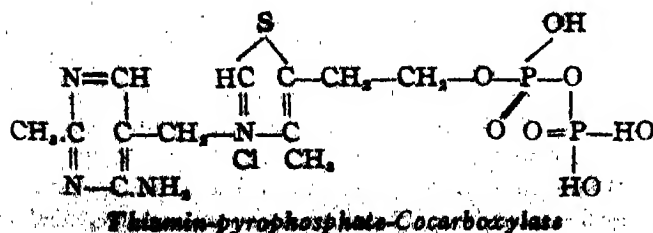
These two grave conditions are enough to illustrate the dangers of nicotinic acid deficiency. We know nothing as yet about the mild, unrecognised condition which may be equally detrimental to health. Nicotinic acid is not only essential for the higher species of animals but also for protozoal and bacterial growth.

The coenzyme function of nicotinic acid possibly represents the main tissue activity of this substance, though the possibility of other additional functions cannot be excluded. It has already been shown that cozymase of blood decreases in both pellagrins and diabetics (Spies, 1939). This is corrected by the administration of nicotinic acid in either case, and the continued administration increases very much the cozymase content of blood.

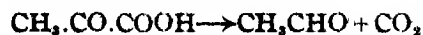
Recent nutritional studies have again shown that certain minerals namely, manganese, cobalt, zinc and magnesium are essential for normal nutrition of animals, even though in very small traces. We did not know what functions these minute traces of minerals could possibly have. Now we are beginning to have a glimpse into this problem. It is found that sodium ions inhibit the action of cozymase. Manganese ions counteract this inhibition by sodium ions, and actually augment the action of this enzyme. Magnesium ions have been found to be necessary for the action of another enzymic system (adenylic acid).

COCARBOXYLASE

Twenty years after the discovery by Neuberg in 1911, of the enzyme carboxylase, which decarboxylates α -keto acids, Auhagen (1932) described its coenzyme. Two years ago Lohmann and Schuster (1937) succeeded in identifying it as thiamin pyrophosphate or vitamin B₁ pyrophosphate. The formula is as follows:



The function of cocarboxylase is to decarboxylate pyruvic acid to acetaldehyde



In this case also, magnesium and manganese ions increase the activity by the enzyme, while acetaldehyde inhibits it.

This discovery at once threw flood of light on the function of vitamin B₁ in animal tissues. Vitamin B₁-deficiency was known to produce the following derangements:

- (i) The accumulation of pyruvic acid in the blood, brain and other tissues of the animal.
- (ii) Very much increased excretion of pyruvic and lactic acid by way of urine.
- (iii) Low oxygen uptake by the tissues *in vitro*.
- (iv) Low heart rate due to the accumulation of pyruvic and lactic acids in the heart muscle.
- (v) Severe polyneuritic symptoms in birds, rapidly cured by administration of vitamin B₁.
- (vi) Decreased sugar tolerance.
- (vii) Failure of appetite, gastric and intestinal atony.

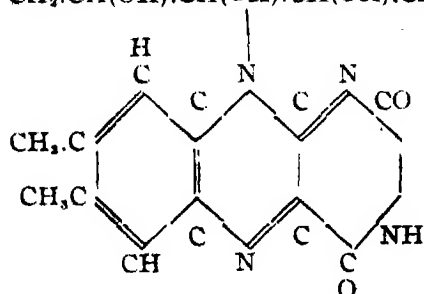
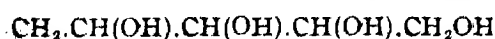
Now all these symptoms are easily understandable when we know that vitamin B₁ is a constituent of cocarboxylase whose function is to oxidise pyruvic acid. In the deficiency of the vitamin the accumulation of pyruvic acid in the tissues occurs and gives rise to all the symptoms and derangements of carbohydrate metabolism described above. It has also been found that there is a reduction of cocarboxylase in the tissues of vitamin B₁-deficient animals and that synthesis of cocarboxylase takes place if vitamin B₁ is administered.

The exact mode of action of cocarboxylase in animal tissues, however, is not yet fully understood, though it is connected with the metabolism of pyruvic acid.

RESPIRATORY ENZYMES

Now let us take the case of another type of enzyme which is not so specific as cozymase or cocarboxylase but is a nonspecific oxygen carrier in cell respiration. In 1933 Warburg and Christian discovered a new type of "Atmungsferment" from bottom yeast. It became soon clear that it consisted

of a protein carrier of high molecular weight to which a yellowish-red dye was attached and which belonged to the class of flavines, a group of pigments widely distributed in nature in both the plant and the animal kingdom. Warburg and Christian found that this enzyme not only had the biological oxygen-carrying properties, but this could also act as a hydrogen acceptor and bring about dehydrogenation of biological substrates. At the same time when Warburg and Christian discovered this remarkable enzyme, Györgyi, and Kuhn and Wagner-Jauregg discovered that flavine constituted the major part of the vitamin B₂-complex. In the following year Kuhn completed almost all knowledge about the flavines—formula, constitution, synthesis:



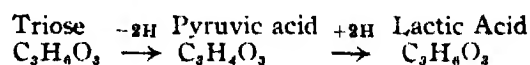
6,7-dimethyl-9-l-araboflavin.

Thus have we had at once a discovery not only of an important vitamin but also of its relation to enzyme, and its role in the tissue cells. In the beginning, the only effects of flavine-deficiency noticed in animals were the cessation of growth, and a non-specific dermatitis and alopecia. Recent studies have shown that certain acute and fatal conditions are associated with flavine deficiency. Sebrell has reported an acute and fatal condition of flavine deficiency in the dog known as "Yellow Liver". It is characterised by bradycardia, cardiac arrhythmia, yellow mottling of liver, degenerative changes in the central nervous system, collapse and coma. In birds an acute paralysis characterised as neuromalacia has been observed which rapidly responds to pure ribo-flavine administration.

FERMENTATION AND OXIDATION IN THE CELL

Finally let me recount one more chapter in this fascinating history of cellular activity which the brilliant researches of Szent-Györgyi have brought to light. Taking the muscle cell as our example, it is well recognised that in this cell hexose is converted

into lactic acid. The manner in which this change is brought about has been shown already in the chart. The fact that the formation of phosphoric acid esters is necessary for this fermentation to occur does not affect our conclusions. The net result is that first hexose—a six membered carbon chain—is broken down to a three-carbon triose. Triose is then changed through pyruvic acid to lactic acid. Triose, $\text{C}_3\text{H}_6\text{O}_3$, has only two atoms of hydrogen more than pyruvic acid $\text{C}_3\text{H}_4\text{O}_3$, while pyruvic acid has two less than lactic acid.



Thus the hydrogen atoms taken out at one stage are added in at the other. The change involved in this fragmentation of the hexose molecule to lactic acid is only a minor change and the energy liberated is of a low order.

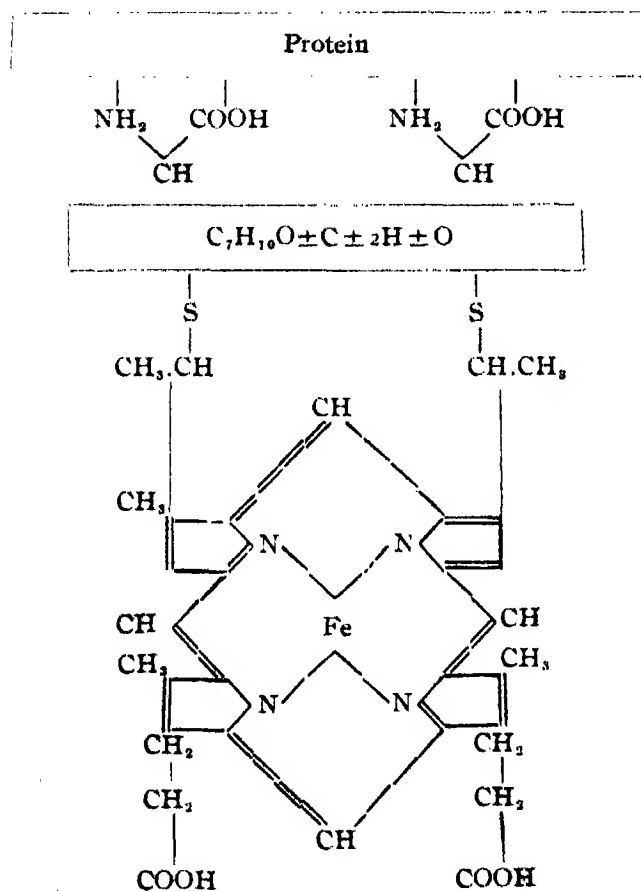
The cell wants energy for life. The energy set free in the fragmentation of the hexose molecule to lactic acid is very small. The only other alternative is to completely burn the hexose molecule to $\text{CO}_2 + \text{H}_2\text{O}$, whereby the bulk of the energy would be set free. This energy would be 30 times more than in the former process. Indeed nature did adopt the latter process of oxidation in order to obtain more energy.

The anaerobic fermentation of hexose to lactic acid whereby only a small amount of energy is set free represents a lower stage in the evolutionary history of the cell. This could maintain only lower forms of life. The evolution of the higher forms of life became possible only after nature discovered oxidation by molecular oxygen, in which case the hexose molecule could be completely burnt. It is a very fascinating story how nature changed over from fermentation to oxidation. In fact it did not completely change over, as both the processes exist today side by side—fermentation, the relic of the older age, and oxidation, the new achievement. Let us now examine the mechanism of oxidation and the manner how it was evolved.

The older process of fermentation by which the cell derived its energy was anaerobic. Oxygen was now to play the chief role in the new drama of oxidation. The molecule of oxygen is a fairly stable entity and cannot be made to do anything which the cell wants, especially at the body temperature. What was necessary was to activate the oxygen. It is the most brilliant achievement of Warburg that he

discovered the catalyst which the cell used for this purpose. This contains iron and is different from the yellow respiratory enzyme. Warburg believed that this alone affected the oxidation but it is only a link in the chain. The next link was Keilin's 'cytochrome-C', a compound closely related to haemoglobin.

Cytochrome, whose formula has not been quite definitely established yet, is very much like what is shown below:



Cytochrome contains an iron atom which is capable of being oxidised from the divalent to the trivalent form. The "Atmungsferment" of Warburg oxidizes the cytochrome.

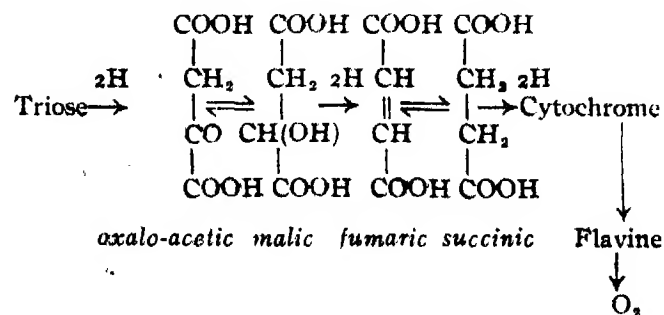
Now it was the discovery of H. Wieland that helps us further in understanding what the cell did. Wieland discovered that as oxygen was being activated through the respiratory ferment and the cytochrome system, so also the hydrogen of the hexose was activated by a system of "dehydrogenases". These enzymes release the hydrogen in such a way that it can be easily given up if there is any substance present to take it over.

The simple explanation now would be that activated oxygen combines with the activated hydrogen and in this way the oxidation proceeds. But even this is not whole of the story.

The discovery of the intervening steps we owe to the genius of Szent-Györgyi. Let us quote his own words:

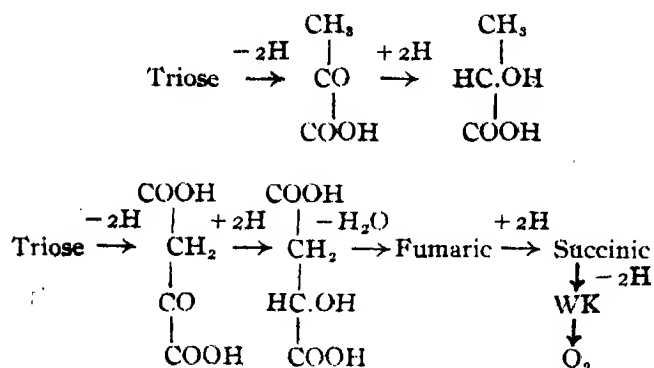
"From the very beginning of my biochemical studies my mind was bothered by the special position of the four-carbon atom dicarboxylic acids. I was taught that succinic acid was oxidized by most animal tissues at a very rapid rate to fumaric acid. Later I convinced myself that there is in fact no other substance oxidized by tissues as fast as succinate. Ogston and Green showed that the only substance cytochrome could act on was succinate. It was also known that all tissues contained a very powerful enzyme, 'fumarase', which converts fumaric acid to malic, till the relative concentration of both is 1 : 3. In the same way it converts malic into fumaric. Later on I found that this enzyme is in fact one of the most powerful enzymes known. But what is its function? Nature is not extravagant, and yet neither succinic nor fumaric acid was regarded as among the most important metabolites. Also Thunberg showed that the isomer of fumaric acid, *e.g.*, maleic acid, was a strong and specific poison of respiration. I began to suspect that something must be wrong about the WK-Wieland theory. It might be true, but must be incomplete, and the C_4 -dicarboxylic acid must play some very important catalytic role in respiration."

Thus Szent-Györgyi embarked on his investigation to find this out. It took several years of hard work to discover the whole chain. It was found that four dicarboxylic acids undertake the work of transferring the hydrogen from hexose to the flavin-cytochrome system.



Thus it was found that such dull substances as these acids, whose formulae we find in the first pages of an

elementary text book of organic chemistry, were found to play such a fundamental role in cell metabolism. But Szent-Györgyi points out another interesting fact *i.e.*, how nature discovered and made use of these acids. Let us put the two systems, fermentation and oxidation side by side.



We realise the remarkable similarity between the two systems. Oxalo-acetic acid is only a carboxy-pyruvic acid and malic acid is only a carboxy-lactic acid. Thus what nature did millions of years ago was simply to carboxylate pyruvic and lactic acids in its older process and add to it the fumaric succinic acids to unload the hydrogen on to the flavin-cytochrome system. Thus by simple carboxylation nature achieved, the remarkably ingenious way of adapting things for a new function.

Here we have thus the complete story of the oxidation of hexose in the cell. The above discussion makes it clear that hydrogen is actually the

fuel of the cell. The carbon atoms in hexose serve merely as pegs to hang the hydrogen or the parcels of fuel on them.

These are just a few fragments of our rapidly developing knowledge about the nature of enzymes and their important role in the phenomena of life. The fundamental importance of these studies will be evident from the fact that the Nobel Prize has come to most of those who have taken a hand in this remarkable achievement.

Let me recount the names serially:

1. Eduard Buchner (1907) for his discovery of zymase and demonstration that a living cell was not essential for fermentation.
2. Otto Meyerhof (1922) for his studies of oxidation-reduction systems in cells.
3. Heinrich Wieland (1927) for his discovery of the role of dehydrogenases.
4. Arthur Harden (1929) for his discovery of cozymase.
5. Hans Von Euler (1929) for biochemical studies of coenzymes.
6. Otto Warburg (1931) for studies of "Atmungsferment".
7. Albert Szent Györgyi (1937) for investigations on the role of 4-carbon dicarboxylic acids in cell respiration.
8. Richard Kuhn (1939) for chemistry of substances of biological importance. (The offer has since been refused due to the Nazi decree).

* Adapted from a lecture delivered before the Journal Club, All-India Institute of Hygiene and Public Health, Calcutta.

Notes and News

Critical Edition of the *Mahabharata*

We have received from the Bhandarkar Oriental Research Institute a statement regarding the progress of the critical edition of the great Indian epic, the *Mahabharata*. As is well known the *Mahabharata* is the longest epic in the world containing, according to tradition 100,000 couplets, but, actually containing about 85,000 couplets. Compared with this, the great epics of the Greeks, the *Iliad* and the *Odyssey*, can be accommodated in two chapters of the *Mahabharata*. Unfortunately there are a large number of different editions differing fundamentally in their contents. The Bhandarkar Institute took upon itself the task of bringing out a critical edition about 21 years ago with a handsome donation of one lakh of rupees provided by the Chief of Aundh, which has meanwhile been supplemented by grants from other sources. The Institute has been able to collect a large number of manuscripts of all ages from all parts of India, from Bengal to the Punjab and Kashmir to Ceylon and has been able to secure the collaboration of a large number of scholars. In reviewing the work hitherto achieved, Dr V. S. Sukthankar, the General Editor reported that in spite of the time passed (now about 21 years) only three of the 18 books have been completed. The first, the *Adiparvan* was completed by the General Editor himself in 1933. The *Virataparvan* was completed by Dr Raghu Vira of the Sanatan Dharma College, Lahore. The latest is the *Udyogaparvan* edited by Dr S. K. De of Dacca University. The General Editor and the collaborators are following in the selection of the text the critical method laid down by the Western savants and this has led to the elimination of a large number of interpolated passages, a notable one being the hymn to Durga recited by Yudhisthira, about which doubts were cherished for a long time. The progress has been extremely slow but the General Editor informs us that by the next year 45 per cent of the work containing 40,000 *slokas* and about 4,500 pages will be finished. The general reader will probably grow impatient, because if the present rate is not accelerated, the completion of the task may take another 30 years. The cause of this slow speed, we understand, is lack of funds.

In fact, the balance sheet is rather alarming and unless the public comes forward with more funds, the work may be suspended in the near future. We warmly support the appeal which has been issued by the Trustees of the fund for more generous response from the public of India towards the completion of this gigantic task. It is said that the *Mahabharata* text was dictated by the sage Vyasa so quickly that only the God Ganapati (or Lord of Hosts) could pen it down. Probably this is a camouflaged version of the fact that a large number of penmen were required to write down the text originally. In finding out the real text, a large number of editors is needed from the very nature of things but a morphological analysis of the text is very much desirable.

The Date of Kalidas

IN the *Nagpur University Journal* of December, 1939, Mr T. J. Kedar, the Vice-Chancellor of the University has taken up the never-ending theme of the Birth Place and Date of Kalidas, the greatest of Indian poets. It is a matter of great regret that the idea of chronology was the weak point of ancient Indians and the date of Kalidas according to different authorities has varied between the first century B. C. and the sixth century A. D. He has been assigned to the period just after the Sunga Kings at the earliest and at the latest to the time of Yasodharman Vishnuvardhan of Malwa, who in an inscription, dated 540 A. D., claims to have routed the Huns. But of late, the tendency has been to assign him either to the time of Chandragupta II (382—413 A.D.), or to Skandagupta (455—472 A.D.), both of whom bore the epithet of Vikramaditya. Mr Kedar examines the various claims and in the absence of historical data supported by monuments and inscriptions he probes into the Kalidas' accredited writings and comes to the view that he must have lived in the first century B.C. after the end of the reign of the Sunga Dynasty. In fact he is in favour of the hypothesis that he lived at the court of a real Vikramaditya of Ujjain about 57 B.C. This view has been put forward earlier, but from entirely different points

of view by Professor Kshetresh Chandra Chattopadhyay of Allahabad University and still earlier by Professor Sten Konow. Professor Chattopadhyay refers to the remarkable similarity in literary passages in the writings of Asvaghosa (the Buddhist poet of the first century who wrote in verse the story of renunciation of Buddha) and Kalidas, and came to the conclusion that the former (Asvaghosa) must have copied from the latter (Kalidas). Professor Sten Konow bases his theory on the Jaina tradition that a certain Vikramaditya expelled the Saka intruders about 60 B. C. from Ujjain. But these views have not yet found favour with the historians. The chief reason being that inscriptions discovered hitherto have not yet revealed a single instance where the era, now known as the Vikrama Era, was called by this name before the eighth century, A.D., and no inscriptional records of Vikramaditya of the first century B.C., reigning at Ujjain has been as yet discovered. Earlier it was known as the Krita Era, or alternatively as the Era of the Malava people.

Mr Kedar shows that Kalidas shows such intimate knowledge of the geography of Central India particularly of the Ujjain region that he must have known it intimately, *i.e.*, he must have hailed from this region. Secondly, he shows such an intimate knowledge of the palace intrigue of the early Sunga Kings of Vidisa, that he could not have been far removed from their times. He therefore positively declares in favour of the 56 B.C. theory. We have in Greece seven cities claiming Homer, but we have here seven centuries, claiming the greatest poet of India. We suggest to the Oriental Conference to hold a symposium on the subject, with a view to coming to a definite decision, if possible, on the available records.

Satakarni Chronology

In the *Journal* of the Royal Asiatic Society of Bengal (Vol. V, 1939) Professor K. P. Chattopadhyay returns to his theory about the chronology of the Satavahanas, which was first propounded by him nearly 13 years ago in the *J. R. A. S. B.* This chronology of ancient India is still far from being settled but no problem had presented a more hopeless maze than the present one. The *Puranas* assigned a period of 455 years to this dynasty and the number of kings in the different Puranic lists varies from 19 to 30. From inscriptional record, the dynasty appears to have ended about 200 A.D. and if the whole 455 years is to be assigned to them, it ought to have its beginning about 230 B.C., that is, before the end of Asoka's reign. But all the *Puranas* uniformly testify that the dynasty was started after the fall of

the Kanvas, that is, about 70 B.C. Many theories have been advanced to solve this difficulty but few have given complete satisfaction. Professor Chattopadhyay holds that the dynasty comprised two lines, one of which reigned over an old ancestral kingdom and the other over a conquered realm. Succession to the throne was from mother's brother to the sister's son. Also the two kingdoms were connected by matrimonial relations (cross cousin marriage) and usually the son of the reigning emperor was appointed to the rulership of the later kingdom by virtue of his mother-right. He is thus of opinion that the periods of reign of the princes reigning in the two capitals have been added together thus giving the large total of 450 years while actually the time period during which the main line flourished did not probably exceed 300 years. Various objections have been taken to this theory by different historians notably by Professor H. C. Raychaudhury but Professor Chattopadhyay appears to have proved to his satisfaction that this theory is substantially correct.

The Netherlands Indies

In the *Geographical Review* of April, 1940, Mr J. M. Broek of the University of California gives an interesting account of the economic development of the Netherlands Indies which may be read with great profit by people of this country in view of the great political changes taking place in the present times. In India we are hardly conscious of the fact, that of the European nations, who once contended for the possession of India, the Dutch still possess the largest area next to that of Britain. In fact, the Dutch are very proud of *their* India. Of the group of islands, which form Netherlands Indies, the islands of Java and Madura are very densely populated and are known as the Inner Provinces in distinction to the Outer Provinces comprising Sumatra, Borneo, Celebes and other smaller islands. Mr Broek gives a very interesting account of the economic changes in the different parts. It appears that the inner provinces have reached almost saturation point in economic development and population, and now the people are migrating towards the sparsely populated outer parts. The staple means of livelihood of the population is agriculture but the enterprising Dutch have in this respect gone in some points beyond their English prototypes in British India, for they have developed many agricultural industries on a wide scale, chiefly for export. These are chiefly sugar, coffee, palm oil, cocoanut products, rubber, cinchona. In fact, at one time Java supplied the whole of India with its sugar but with the development of the industry in India the Java sugar industry has undergone marked decline. For cinchona, India

is still dependent largely upon the Java product though India offers unique opportunities which have not yet been fully taken advantage of. The different provincial governments in India may take a lesson from the Dutch government because none of them has completely studied the possibilities of starting new agricultural industries in India. Java is further rich in minerals. It produces 3·4 per cent of the world's total of petroleum, and the eastern countries are to a large extent dependent upon Javanese supply. The outer provinces are still mostly unexplored, but they are attracting the notice of the capitalists. They are mostly covered with dense forests containing large amount of economic products like timber, resins, wild rubber, bee-wax, and the enterprising Dutch Forest Service has got a comprehensive scheme of development. We learn from this paper that for a long time Java was the main profit area and remitted large sums of money to the Netherlands. But during the last 30 years the 'burden of the Dutch Empire' has been shifting to the outer provinces. The natives of the Java have however shown very little enterprise in the industrialisation of their country and sometimes the Dutch people advertise this fact as an argument in favour of their continuance on the island. But generalisation of this theory of permanently imposing one nation over another is rather too dogmatic. The superiority of the Dutch, and for the matter of that, of the Western peoples, is not their exclusive property. For, another Eastern people, the Japanese, have shown themselves to be as much enterprising and aggressive as any Western people. They are now clamouring for their *Lebensraum*, which will have to be found possibly in eastern and south-eastern Asia.

Alleged Discovery of the Element No. 85

We learn from the *Science Digest* that the Swiss University Press has published the account of the alleged discovery by Dr Walter Minder, Chief of the Radium Institute at Berne, of the missing element No. 85 in the Periodic Classification. Up to the time of writing, three elements in Mendeléeff's Table have not been discovered with certainty. These are Nos. 61, 85 and 87. Of these, No. 61 has been claimed to be discovered by an Italian and an American, but their story of discovery has not yet found general credence. Element No. 85 which is claimed to have been discovered is analogous in properties to iodine and may be called radio-iodine. It has been obtained as an impurity in radium to the extent of 1/10000th of a milligram. It has been christened Helvetium in honour of Switzerland. The story so far given is so meagre that people must wait for further details before they can be persuaded that the claim is a

genuine one. Element No. 87 which is similar to caesium in its properties and would be an alkali is also still missing, though claims have been made by several workers. A number of leading scientists are of view that the missing elements 61, 85, 87 are unstable from the very nature of their nuclei and therefore cannot occur in nature.

Quater-centenary of Copernican Theory

EXACTLY four centuries have elapsed since the Polish astronomer-monk, Nicholas Copernicus, revived the theory that the earth and the planets revolved round the sun as centre. We say revived, because the Babylonian Selucus (who lived in the third century before Christ and was not a Greek in spite of his name) and somewhat later the Greek sage, Aristarchus Samos actually propounded this theory in the 3rd century B.C., but it was rejected by Ptolemy (150 A.D.) whose lead was followed by other astronomers. But as observations multiplied, the Ptolemaic theory was found more and more untenable and had to be supplemented by making the planets move on subsidiary circles (epicycles and deferents) till the whole thing became so complicated that an astronomer-king, Alfonso XIII of Castille, remarked that if he were present at Creation, he would have advised God to make His system simpler.

Born on February 19, 1473, Copernicus studied at the University of Cracow and after three years, left for the University of Bologna in 1496, where his special subjects of study were astronomy and mathematics. Copernicus found that the simple heliocentric theory gave a far better explanation of the movement of planets. He came to this conclusion in 1500, but he could not publish his theory for fear of opposition from the Church and papal administration. In 1539, however, Copernicus sent a brief account of his new ideas to his old teacher, John Schoener, at Nuremberg; and his '*First Account*' (*Narratio Prima*) was published at Danzig in 1540, exactly 400 years ago. Thus he had to wait for more than forty years before he could publish his discovery; for, the truth was 'contrary to Scripture' which said that the earth was the central Creation, and the two lights were created to illuminate her, the bigger light, sun, to illuminate her during the day and the lesser one, moon, during the night. Later he decided to publish his entire work '*De Revolutionibus Orbium Coelestium*' or '*On the Revolutions of the Celestial Orbs*'. The first printed copy of '*De Revolutionibus*' reached Copernicus on May 24, 1543, the day he expired at the age of seventy. Curiously enough, his book was dedicated to the then Pope, who received it graciously, probably never suspecting its contents. But later the book

was proscribed and forbidden against teaching it in schools and universities. Much of such oppositions against science can be found in the life histories of Galileo and Bruno ; Bruno being burned at the stake.

Copernicus is truly called the father of modern astronomy, and although his discoveries received attention of the scientists and astronomers, no English translation of his work has so far appeared. Recently, however, Mr Edward Rosen's English translation of the *Narratio Prima* has been published by the Columbia University Press. Were it not for the present war, scientists in Germany, Poland and other European countries might this year be celebrating the important anniversary of the Copernican theory first made public in 1540. We understand however that Mr Rosen has plans to translate *De Revolutionibus*, and to issue it before 1943, the quater-centenary of its original appearance.

Technical Terms in Indian Languages

THE problem of a common script for India is fairly old now. To give the least offence to both the Hindus and the Muslims a new language 'Hindusthani' with an extremely limited vocabulary, bereft of nearly all Sanskrit and Perso-Arabic words as used by the intelligentsia and in the books, has been suggested as the common meeting ground between Hindi and Urdu of today. Following this wave of public enthusiasm, the medium of instruction in a number of universities has been changed to the regional languages but provincial patriotism has so long stood in the way of finding out a *lingua franca* for the whole country and also a script for that.

Mr K. P. Sagreiya, silviculturist at Nagpur has recently devoted *inter alia* much thought to this problem in his article on Translation of Technical Forestry Terms in Indian languages in the *Indian Forester* of October, 1940. Already for teaching (even in colleges up to the highest degree in Hyderabad) translation work has been done by Osmania and Calcutta Universities, Gurukul Mahavidyalaya, Hindi Sahitya Sammelan (Benares) and also indirectly by the journals *Vijnan* in Hindi from Allahabad and now defunct *Prakriti* in Bengali from Calcutta.

The new language Hindusthani as the *via media* between modern Hindi and Urdu being primarily designed as the spoken language is inadequate for literary or scientific purposes, and it is exactly at this point that the divergence comes. There is no difference in the language, as used by a Hindu or a Mahomedan of U. P. for ordinary purposes of life, but when required to express higher thought, the

Hindu falls back on Sanskrit and the Mahomedan on Arabic and Persian. The correct line of approach to this serious obstacle of multiplicity of scripts and undeveloped languages, in the path of educational progress will not be by imposing a made-to-order language, viz., Hindusthani. Mr Sagreiya while dealing with the problem of translating the scientific terms has suggested the harnessing of the two main languages equally in this task immediately. He has planned a bold step and insists on every child being taught two synonyms for every English word, one derived from Sanskrit and the other from Perso-Arabic, besides the corresponding equivalent in the regional language (which so far as technical terms are concerned will in 90 cases out of 100 be either the one or the other, for instance, *king* meaning *Raja* and *Badshah*, and *country* meaning *Desh* and *Mulk*). Every one will have the freedom to use one or the other or sometimes one and at other times the other according to his liking, but we should insist on his understanding and recognising the other equivalent used by some one else. For the present, we think the question of Hindi vs Urdu may be solved satisfactorily in this manner without wasteful public agitation. Mr Sagreiya's suggestion is quite ingenious and will be very helpful in the transition period. With lapse of time we believe the duplicate list of words will pave the way for a single comprehensive list throughout India, and each word will be incorporated, specially for teaching and writing purposes, on its merit of accuracy and simplicity. The best word will survive. At one time, there were 72 words used for gas, but the word 'gas' (which some say was derived from chaos) has survived on account of its simplicity.

The advent of Industrial Revolution and the development of printing presses in other lands had very little effect on the different scripts existing in our country. These remained neglected without any attempt at their development. Some of the oriental scholars in the foreign countries for the convenience of making available their studies to the readers adopted the Roman alphabet with various signs for transcribing the different Indian languages. There should be no false sense of national vanity and of sanctity of our ancient culture while discussing about a common script. The Germans have discarded Gothic in favour of Roman alphabets. Similarly, in order to have more intimate international intercourse the Turks have also taken up the Roman script for their language. We are also in favour of our adopting the Roman script (see SCIENCE AND CULTURE, I, 117, 1935-36).

The International Congress of Orientalists at Athens in 1912 adopted a scheme of transcription of all Hindi sounds in modified Roman script which is still the only rational and satisfactory

method for transliterating Sanskrit. Mr Sagreiya however has suggested a modification in this method. He claims that in adopting his system for expressing modern Hindi sounds only 37 symbols will be needed as against over 200 different types at present used to correctly print Hindi in the Devanagari script (because half-consonants, conjunct-consonants and vowels-in-combination-with consonants change their form altogether, and besides linear composing as is the case with the Roman script in Hindi, parts have also to be inserted above and below the line). The above script has been also adapted by him for typing by using the signs of colon, accents etc., in the ordinary present-day typewriter.

Mr Sagreiya has prepared this modified script and has suggested uniform translation of technical terms in the two principal languages of the country for the immediate convenience of his forest staff and desires that a start in this direction may be made at the next session of the All-India Silvicultural Conference. Some work on the subject has already been done in the Punjab where a committee of forest officers has been formed to prepare a glossary of technical forestry terms in Urdu, (*vide* item 10 of the Punjab Forest Conference, 1939), who are proceeding in the task with the help of Osmania University.

Cyclone at Bombay

AN account of the recent Bombay cyclone and of the warnings issued to ports on the west coast has recently been released by the Director-General of Observatories, Poona. The charts prepared at Poona from the daily routine observations of 8 A.M. and 5 P.M. gave indications of the impending foul weather and accordingly during the progress of the storm special observations from selected stations were also called for. But it was necessary to infer positively the weather out over the Arabian Sea. If the observations made at the observatories along the west coast of India were supplemented by observations from steamers at sea, the forecasting could have been improved and the terrifying nature of the depression could have been appreciated in time. Due to exigencies of war the observations out in the sea were not available on the present occasion. The development of the storm out at sea was therefore judged from its secondary effects and the positions of the centre estimated approximately. Though signals were augmented by special observations, unfortunately the last signal arrived in Bombay just when it was experiencing the strongest winds of the storm. The meteorological warnings, it should be noted, can at best be circulated after three hours from the time of observation. This is due to the time taken by the observation telegram to reach the fore-

casting centre, the time taken for decoding and plotting the observations on the charts and lastly the time required for analysing the charts before the meteorologist can decide upon appropriate warnings.

The origin of the storm is traced to a feeble low pressure wave from the Coromandel coast (where conditions were unsettled on October 7) to the Arabian Sea. This movement gave indications of a spell of thundery weather off Malabar, Kanara and Konkan on October 8. On the evening of October 9 conditions seemed definitely unsettled off the Malabar-Kanara coast. On October 10 a depression was believed to have formed with centre out at sea within two degrees of Lat. 13° , Long. 70° (a position little over 120 miles south-west of Bombay), which on the evening chart of the same day, was centred within two degrees of Lat. 14° and Long. 70° and was moving in some northerly direction. These conditions reigned for the next day. On October 12 there were indications of a weakening of the depression, which continued till October 13. But next morning conditions reversed and became markedly unsettled off the coast from Ratnagiri to Mangalore. Towards the evening a depression seemed to exist in the east central Arabian Sea.

Special observations at 2 A.M. were asked for from a number of observatories on October 15 in order to watch the situation. On the 8 A.M. charts of that day it was announced that the depression had moved much nearer Bombay and was moving in north-easterly direction. The 10 P.M. chart indicated the storm centre to be still nearer Bombay but it was then thought, in the absence of any data from ships at sea, that the movement was towards the Gulf of Cambay. The direction of the movement changed quickly and the 5 P.M. chart showed that the cyclonic storm, at that time of small diameter, with hurricane force winds at the core was rushing towards Bombay. This storm-centre passed just to the west of Bombay on its north-east track and in course of the day crossed the coast some 50 miles to the north of Bombay. It was inland near Surat by next morning. From the moment it crossed the coast the storm weakened slowly into a depression, but after reaching Surat it remained stationary for three days. This halt of a depression over one position for so long is most unusual. It filled up finally *in situ* by the morning of October 21.

Migration of Culture to America

WHEN the Ottoman Turks under Mohammed I conquered Constantinople in 1453, and put an end to the Byzantine Empire, there was a general exodus of scholars to Western Europe, notably Italy and Germany. It is usually believed that these scholars

brought with them a knowledge of Greek literature, philosophy and science to a barbaric Europe, and made it possible for the eager souls of Europe to drink first hand at the fountain source of Greek knowledge. This ultimately led to the great movement known as the Renaissance.

Since the beginning of the present war, there has been again an exodus of learned men and scientists on an almost equal scale from warstricken Europe to the peaceful United States of America. Prominent amongst such scholars are:

- Albert Einstein (now a U. S. A. citizen, and professor at Princeton, Nobel Laureate);
- H. Bruning (Hitler's predecessor in office);
- Thoman Mann (German author, Nobel Laureate);
- Werner Jaeger (Classical scholar);
- Martin Wagner (City planner);
- Walter Gropius and Marcel Breuer (Architects);
- James Franck (physicist, Nobel Laureate, formerly at Gottingen, now at Chicago);
- Enrico Fermi (Italian physicist, Nobel Laureate, formerly at Rome, now at the Columbia University, New York);
- Bruno Rossi (Italian physicist);
- Otto Stern (German physicist);
- Peter Debye (Dutch physicist, but professor at Berlin, now at the Cornell University, Nobel Laureate);
- Giuseppe Borgese (Italian novelist);
- Ulrich A. Middeldorf (Art teacher);
- Spiro Kyropoulos (German-born; carrying on important research on oil. Now at California Institute of Technology);
- Arnold Schonberg (Composer, now at the University of California at Los Angeles);
- Otto Marburg (Viennese neurologist, now at Columbia University);
- Fernando de los Rios (once Spanish Ambassador, now at the graduate faculty of Alvin Johnson's Institute);
- Erwin Piscator (one time director of Berlin's People's Theatre);
- Fritz Lachmann (Economist);
- Bertrand Russel (English mathematician, philosopher, and man of letters. The American papers announce that he is going to take U. S. citizenship);
- Ivor Armstrong Richards (Linguist, now at Harvard University);
- Bronislaw Malinowski (Anthropologist, now at Yale University);

Alvar Aalto (Finnish architect);

Lancelot Hogben (an English scientist, who wrote '*Mathematics for the Millions*'. He was on a lecture tour to Norway when the country was invaded by Germany and escaped with great difficulty with his equally famous wife Dr Enid Charles, a statistician, to Russia and ultimately to the U. S. A. He has expressed a desire to stay in the States if he can get a job).

This list gives information only about a few of the large number of eminent scholars who have found a home in America. So far, it seems to be only a one-way process. During the last war, the English writer Houston Chamberlain, a champion of the supremacy of the Nordic race, became naturalized as German, but in the present war, no example of any notable Englishman becoming a German or an Italian has been yet known, unless we except that mysterious personality of Lord Haw Haw.

Automatic Weather Reporter

For the last eight months an automatic weather station is functioning at an U. S. Naval Air Station. The station utilizes the same principle as the radio sonde. The radio sondes are used in unmanned balloons which give weather information of upper air, at heights which even stratosphere-flying airplanes cannot yet achieve. The radio sonde transmits dots or dashes and the records of these in a receiver are later interpreted in terms of barometric pressure, air temperature, and relative humidity. The wind velocities and directions are found by visual inspection or radio bearings.

The new weather robot, fit for stationary installations, is designed to transmit meteorological information at predetermined intervals. The variation in the meteorological element is converted here into a change in resistance which in turn produces a change in modulation frequency. The essential difference from the radio sondes lies in the use of much lower frequencies, 0.15 to 3.0 cycles per second. The station is equipped with a 15-watt radio transmitter with battery power-supply. The standard designs of each of the pressure, humidity and rain gauges have been provided with a relay-operated clamping bar which fixes instrument pointer against the edge of a wire-wound resistance and the instrument deflection is converted into a resistance variation. When no observation is transmitted, the pointer swings freely. The temperature element is a glass capillary tube filled with an electrolyte having a high temperature co-efficient of electrical resistance. The resistance of this device is a function of the

surrounding temperature. The wind direction indicator has got eight contact segments corresponding to the eight principal compass points. A different fixed resistance is connected to each segment and is thrown into circuit when the wind vane assumes that direction. Intermediate directions are indicated on a proportional basis by the successive contacts of the wind vane (due to its oscillation about the average direction) with the adjacent principal vanes. The wind velocity indicator is a standard commercial cup anemometer with the "take off" contacts stepped up by a factor of four so that four contacts per minute correspond to one knot. There is a modulating equipment for keying the radio transmitter at a rate depending on the value of the particular variable resistance in circuit. An automatic control equipment connects the instrument resistances into circuit in a definite sequence and identifies the several observations by appropriate code letters. A timing clock starts the equipment at scheduled times. The average errors obtained in the measurements are exceedingly small and the advantageous feature is that any field crew may receive these observations by means of an ordinary radio receiver, headphones and a stop watch. Full details will be found in the August issue of *Journal of Research*.

Madras Government Museum

Under the superintendence of Dr F. H. Gravely, an important extension to the Government Museum, Madras, has been completed and opened to the public. Its main function is to give suitable expression to the evolution of the decorative motifs of the architecture of the magnificent temples of South India. For the Tamil country, these changes form an interesting and logical sequence. The temples of other parts of India differ from those of Tamil origin and in this section attempts have been made to indicate the succession of changes that has taken place during the course of development of Tamil architecture.

Racial Characters in Ancient India

DR WILTON M. KROGMAN of the University of Chicago, has published the result of examination of a skull from Chanhudaro, a site of the Indus valley civilisation in Northern India. The skull is that of a young woman and was placed in a jar after decapitation. It is surmised that it may have been that of a princess or priestess. It was found in the course of the excavations carried out by an expedition of the Boston Museum of Fine Arts and has been dated as belonging to a period some five thousand years ago. Dr Krogman's report indicates a

combination of characters usually to be assigned to diverse racial types. There are such Negroid characters as a flattened head vault, broad nose opening and low eyesockets with Caucasoid features, such as narrow nasal bones, small teeth and narrow distance between the eyes, as well as in the shape of the palate. His conclusion is that it represents a "Proto-Mediterranean type in which ancestral Negro traits have manifested themselves". Dr Krogman suggests that the modern Mediterranean race may once have had a mixture of Negroid blood which has since been eradicated.

Lac Research

RESEARCH work carried out at the Indian Lac Research Institute and the London Shellac Research Bureau during the year 1939-40 shows that greater emphasis has been laid on the practical application of the results of experiments. The Indian Lac Cess Committee's annual report for that year, states that the outbreak of war resulted in a rapid development of the activities of the London Bureau owing to the demands of the Defence Departments for various types of luminous and black-out paints, coating composition for anti-gas clothing, a quick-setting cement for metals, a flexible and grease-proof coating for rubber surfaces, a quick-drying oil-resistant paint for metals, and a quick-drying sea-water resistant paint. The process of hot-spraying of lac, worked out in the London Bureau, promises to open up commercial possibilities. Full details of this have been published in *Bulletin No. 5* of the London Shellac Research Bureau.

Experiments are in progress at the Indian Lac Research Institute for the production of modified shellac powders for the moulding industry. The use of these powders in the making of electro-technical goods and a variety of common household articles will open up a considerable field for new industries. Practical details have been formulated for the manufacture of plastic moulded articles, motor car finishes and stoving enamels from shellac. A number of experiments have been designed to minimize the use of imported materials in the processing of shellac for these new industries. The Lac Cess Committee has entered into an agreement for co-operative research with the India Moulding Company, Calcutta, which will be helpful to investigate the processes under actual commercial conditions.

Buddhist Manuscript at Lauriya Nandangarh

IN the extreme north of the province of Bihar at Lauriya Nandangarh a pillar of the Emperor Asoka was excavated some years ago in almost complete

preservation. The pillar marks one of the sites of the pious king's visit from his capital near Patna to the birth-place of Buddha. The name, 'Lauriya', strictly applies to the village near the 'laur' or 'pillar', on the neighbourhood of which a number of mounds were some time ago examined by the Archaeological Department; and Nandangarh is the name of a large garh or fort, lying at some distance from Lauriya and thickly covered with jungle. A stupendous monument discovered here is unequalled for its size and is possibly the earliest prototype of the architecture of the Burmese and Malayan *stupas* and the well-known Borabudur monuments in Java. The plan of the monument is a huge square cross with a number of projections in between the arms of the cross. As in the great temple at Paharpur in Bengal there are also several terraces rising one above the other. The evidence of the finds shows Paharpur to be much later in date than the Nandangarh mound. On the assumption that the monument must have been erected by the Buddhists, a shaft was dug in the centre and at a depth of some 36 feet from the top a complete *stupa*, a miniature of the exterior of the monument, has been uncovered. This is surrounded on all sides by a low platform at the foot of which has been found a copper casket containing a strip of white muslin with fragments of a birch-bark manuscript and small pieces of wood and carnelian beads. As the manuscript had been forced into the casket, it was found impossible to open the individual leaves without breaking. These have been found to contain certain Buddhist texts written in characters of the 3rd-4th century A.D. It appears that the original monument was several centuries earlier than the casket and the manuscript with which it was apparently reconsecrated at a later date. The present find is, important, being the only one from eastern India wherein an original manuscript has been recovered. So far all such discoveries have been confined to the north-west parts of India.

Indian Students in Great Britain

THE Report on the work of the Education Department under the High Commissioner for India for the academic year ending 30th September, 1939 has just been published. There were over 1500 students, and their academic, athletic and other records were quite satisfactory. Over 600 students were engaged in research and 300 pursuing courses in various branches of engineering and technology. About 100 were studying agriculture and veterinary science. The Secretary of the Department has again

drawn attention to the futility of sending boys with the sole purpose of securing a better Service appointment. He lays stress on the personal qualities of character and steadiness, in addition to educational qualifications, which should guide the guardians. Another point in the report deserves serious consideration. The number of full-time students in the faculty of medicine at the different universities was 474. Medicine has all along attracted the largest number of students but it is to be regretted that the spirit of scientific enquiry has not been found in most of the persons who have returned bedecked with a number of degrees and with the membership of various colleges. Some even begin their medical courses in Great Britain but few have been reported preparing specifically for some research course. Up till now very few students, if any, have been found to take up research in a field largely untapped in this sub-tropical country. The Report informs that the Royal College of Surgeons, England, has decided to grant in principle recognition of resident surgical posts held at Indian hospitals not associated with the universities and medical colleges in India, for the purpose of satisfying the relevant regulation for admission to the Final F. R. C. S. examination in London. The Institution of Mechanical Engineers has also decided to recognise the engineering degrees of Benares Hindu University and of Bombay University, and exempt the holders of such degrees from part II, section A, of their Associate Membership examination. So far university education is concerned the facilities are fairly satisfactory though the utility of it for each of the boys that now go is doubtful. The opportunities for practical training are however meagre and we shall discuss about it in a subsequent issue.

Announcement

A LARGE collection of reprints, bulletins, memoirs etc. on mycology and plant pathology has recently been presented by Dr B. B. Mundkar of the Imperial Agricultural Research Institute, Delhi, to the Fergusson College, Poona. The collection consists of about 5250 publications, besides complete sets of 'Mycology' and 'Phytopathology', and several books on these subjects. The collection is specially rich in the works of American, Finnish, Swedish, German, Swiss, Italian and English mycologists and plant pathologists, and for the present will remain with Dr Mundkar so that he can use it in his investigations.

SCIENCE IN INDUSTRY

Transferring Heat in Chemical Processes

FOR heating a substance the source of heat should be at a higher temperature than the substance to be heated. By means of direct firing, where the heat is transmitted by radiation, or conduction and conduction-convection from the flue gases, materials can be heated to a very high temperature depending on the temperature of the furnace. But in many chemical processes, where a close control of heat is of utmost importance, heating by direct firing is unsuitable. For a closer heat control, a medium is necessary, which, after receiving heat from the furnace, is circulated through coils and pipes and transmits heat through them to the substance to be heated.

Media for low temperatures are many, but heat transfer media for higher temperatures have always presented a serious problem to the chemical engineer. Steam, water, flue gas, and air are the most widely used and cheapest heat-transfer fluids. The boiling point of water is 100°C . or 212°F . at atmospheric pressure. Now if a substance is to be heated to a higher temperature than this by means of steam, the boiling point of steam is raised by raising the superincumbent pressure on it. Even then, the upper limit for steam, so far used for heating purposes, is 460°F . corresponding to a pressure of 450 pounds per square inch. Although modern high-pressure boilers produce steam having much higher temperatures than the above, their use for heating purposes is most uneconomical. Flue gas and air temperatures can be much higher and though their temperature range is wide they have several serious drawbacks for use in many chemical processes. Their specific heat per unit of volume and heat-transfer co-efficients are very low. Great volumes of gas are therefore necessary to transfer relatively small amount of heat. Furthermore it is difficult to control the temperature with flue gas and air and local over-heating is liable to occur.

Mercury (boiling point 673°F . at atmospheric pressure) is, in many respects, an ideal heat-transfer fluid for the temperature range above that of steam. But the cost is prohibitive and due to its high density the equipments to handle it should be heavy

and consequently costly. Moreover there are hazards due to toxic vapours leaking through the system. In some installations molten lead is used as a heat-transfer medium but its use has not attained any commercial importance.

Hot oil, Dowtherm and HTS are the principal commercial heat-transfer fluids now available in cases where temperature of steam is insufficient and in which flue gas is inapplicable. The practical top limit for oil is somewhat above 550°F . and that for Dowtherm (see SCIENCE AND CULTURE, 5, 297, 1939-40), which is a mixture of 75 per cent. diphenyl-oxide and 25 per cent. diphenyl, is approximately 700°F . at a pressure of 135 pounds per square inch. Both the oil and Dowtherm are organic materials and they begin to coke and plug up pipe lines at temperatures higher than those mentioned above.

Important Heat-Transfer Fluids

Fluid	Usual Temperature limits, deg. F.	Pressure Lbr/sq. in Gauge.
Steam or water	32—460	0—450
Oil	30—550	0
Dowtherm A (75% diphenyl oxide, 25% diphenyl) ...	54—700	0—135
Mercury	37—1000 or higher	0—180 or higher
HTS	290—1000	0
Flue gas or air	Up to 800 in iron ducts, to 1600 in special alloys.	0

A molten mixture of nitrates and nitrites of sodium and potassium is known as HTS. It has very recently come into industrial use as a heating liquid. It consists of approximately 40 per cent. NaNO_3 , and 53 per cent. KNO_3 by weight. Similar nitrite and nitrate mixtures are being employed for many years in molten baths for the heat treatment of the metals and in small installations requiring heat-transfer at a high temperature

level, but was not of so much commercial importance. Now chemical engineers are using it on a large scale in Houdry process of catalytic cracking and refining of petroleum. Extensive investigations into the properties of such nitrite and nitrate mixtures were undertaken and finally the above mentioned proportions of nitrites and nitrates of sodium and potassium have been adopted because they have a low melting point of 288°F ., high heat-transfer coefficients, a lack of corrosive action on steel at temperature above those obtainable with Dowtherm, hot oil, or steam, and a good thermal stability. Depending on operating conditions, the upper limit for HTS seems to lie at present in the range of 900 to 1100°F . under atmospheric pressure.

N. K. S. G.

Transparent Fabrics Impermeable to Fluids

ACCORDING to a recent report a new process has been developed by the Imperial Chemical Industries for making fabric transparent and impermeable to fluids, and at the same time increasing their gloss. The process consists in impregnating the fabric with nondrying oil or semidrying oil-modified polyhydric alcohol polybasic acid resins in conjunction with urea-formaldehyde condensation products. Silk or rayon fabrics are treated by immersion in a solution of a synthetic resinous composition in a volatile organic solvent, volatilizing the solvent at 70° to 80°C . and subjecting the fabric to further heat treatment. If necessary the treatment is repeated. Plasticizers like dibutyl phthalate or tricresyl phosphate are used. The oil-modified polyhydric alcohol polybasic acid resins used are glyceryl phthalate resins modified with oil such as soybean, sunflower, safflower, walnut, or poppyseed, the proportion of the oil in the resin being from 35 to 55 per cent. by weight, the middle range, 40 to 50 per cent. being most usual. The modified resin, in which part of the polybasic acid is replaced by monobasic acid derived from a nondrying oil used in the process, is generally a castor-oil-modified glyceryl phthalate resin.

Dyed or printed fabrics as well as cotton fabrics are being treated similarly but the proportion of the chemicals and the treating temperatures are different depending on the nature of the fabrics. It is claimed that the new process eliminates discolouration when fabrics are subjected to heat treatment for short periods of time; and that it imparts excellent flexibility, softness, freedom from cracking or powdering and from objectionable tendering.

N. K. S. G.

Glowing Carpet

ABSOLUTE darkness is necessary to bring out the full beauty of the modern motion pictures in colour. This drive towards perfect darkness has increased the chances of accidents to people entering the cinema house from brightly lighted outside. The shaded lights along the aisles of theatres, which illuminate only the area near the light do not fully eliminate the danger of slipping. Moreover they interfere with the picture itself. A recent report from the Calco Chemical Division, American Cyanamide Co., reveals that a new "magic carpet", which will glow in the dark, will henceforth avoid the above-mentioned trouble. The new carpet is dyed with special dyes which appear quite ordinary in daylight but glow softly with various colours in the "black light" of invisible ultraviolet rays. The paths will be covered with carpets dyed with fluorescent dyes and small electric tubes will shed ultraviolet rays on the carpet. The exact nature of fluorescence has not yet been completely understood, but it seems that when ultraviolet rays are absorbed by fluorescent materials, they radiate soft visible light, which shows the path clearly but does not interfere with the beauty of the modern coloured pictures. It is stated in the report that the application of fluorescent dyes as guides in the dark is expected to have important uses in other fields.

N. K. S. G.

Indian Grape Vines

THE Agricultural Marketing Adviser in his *Report on the Marketing of Grapes in India and Burma* states that grape vines in Mysore State and Bombay Presidency give the highest yield of table grapes in the world. The average yields in these areas are 11,610 lb. and 11,160 lb. per acre respectively; the next highest yield is 7,678 lb. in California. But the area and quantity produced in India is very small. India produces only about half her requirements of fresh grapes and practically no dried raisins or currants, although she imports 225,000 maunds of these every year. To meet the requirements of her own markets India would have to treble the present acreage of grapes, which is now 4,200 acres. This would involve an addition of sixty or seventy lakhs of rupees to the agricultural income as at present derived from that crop. More than half of the present acreage is in Baluchistan, nearly a quarter in Bombay Presidency and the remaining portion distributed amongst the North-West Frontier Province, Madras Presidency, Sind and Mysore State. The total production of grapes in 1934-35 has been estimated at 375,000 maunds, valued at about Rs. 25,00,000.

India ranks sixth among the principal importing countries. The average annual imports are 272,000 maunds valued at Rs. 21,78,000. The major portion of this quantity comes from Afghanistan; the United States of America, the Union of South Africa and the Commonwealth of Australia together supplying about 2 per cent. only. Burma imported from India about 2,200 maunds in 1935-36; but the bulk of this consisted of "Chaman" grapes which were re-exported from Calcutta.

As a stabilising influence on prices, it has been stressed that the important factors are a regular and more efficient news service between producing and consuming areas, wider dispersion of the produce to smaller consuming centres, chiefly through improved transport facilities, and the provision at distributing markets of conveniently situated cold storage accommodation for the relief of temporary day-to-day surpluses. The provision for these depends on the State. But before the demand can be made insisting more research work is necessary in the production of these fruits. In India very little work has been done in classifying existing varieties and in evolving new varieties and types of grapes likely to be more profitable than those under cultivation. At least one or two experiment stations in grape growing areas might undertake this work. There is again the problem of poor keeping quality, which stands against transport to distant markets. Problems relating to grafting and budding, training and pruning, manuring and spraying of vines with insecticides and fungicides also require attention. In the propagation of vines with a view to extension of the existing area it is desirable that there should be a system of registering approved nurseries, some of which at present sell stocks which are not genuine. But in this task also a precise knowledge of the morphological characteristics of the different varieties of vines and root stocks has yet to be acquired by the fruit specialists.

Glycerine Substitutes

Investigations into the production of substitutes for glycerine were first started in Germany during the war of 1914-18. The famous Protol process is based on the fermentation of sugar, starch or maize. Recently an American process was announced which synthesises glycerine from propylene, broadly by means of chlorination and later replacing chlorine by the OH-groups from alkali. This propylene is generally obtained as a rich constituent (30%) of the gases from petroleum subjected to cracking process. In Germany where petroleum supply is deficient, they are trying to improve the poor yield of this raw material from coke oven gases. It should be remembered that the search for substitutes is based on the specific uses to which they will be put. Some should possess more or less the same physical and chemical character as glycerine itself and others might be useful if only there is a resemblance in the physical properties. As a result of investigations so far glycols and erythritol have been classified in the first group which are suitable for the manufacture of explosives and synthetic resins. In the manufacture of transparent cellulose sheet and resin, Sorbitol syrup prepared from glucose is now under investigation in America. In Germany, the marine plants have a rich source of Mannitol, which is closely related to Sorbitol and is used in explosives. The second group resembling only in physical properties includes lactates, notably sodium lactate. These materials are used in place of glycerine as textile assistants and as shock absorbers in artillery recoil buffers and the like. In place of glycol some lactates are also used as anti-freeze agents. In tooth pastes and cosmetic preparations sugar or starch syrups have been suggested as substitutes. But for the medicines no replacement has yet been possible. Propylene glycol has shown possibilities while in printing rollers and hectograph apparatus glycerine is still the only substance.

Artificial Silk Industry

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SINCE the last Great War, the growth of the artificial silk industry has been tremendous and the manufacture of artificial silk has become one of the major chemical industries of the world. In the first phase of its development, the United States played

an important part. In 1930, the American production excelled that of Germany, England and Italy taken together. But during the last ten years, the situation has radically changed. The policy of economic self-sufficiency, specially in the case of vital

raw materials, has been intensified during the last decade in anticipation of war. As a result, countries which are poor in textile raw materials have directed their attention to the development of synthetic fibres with a view to becoming independent of foreign supplies. Japan, Germany and Italy have now become the principal producers as the following table will show:—

TABLE I.

SHARE OF DIFFERENT COUNTRIES IN THE PRODUCTION OF SYNTHETIC FIBRES.

(In million pounds)

Countries.	1929		1937.	
	Art Silk.		Art Silk.	Staple Fibre
U. S. A. ...	112		282	18
Italy ...	59		98	140
Germany ...	45		115	200
France ...	37		—	—
England ...	63		108	32
Japan ...	18		300	155

The above figures indicate the enormous increase in recent years not only of artificial silk yarn but also of short "staple" fibre which is used either as a substitute for cotton or in admixture with it. Evidently the staple fibre has been welcomed in the market, for countries like U. S. A. and Great Britain which command enormous cotton resources are also increasing the production of staple fibre. While the world production of artificial silk yarn is slowly increasing, that of staple fibre is increasing by leaps and bounds (table II). This is due to the efforts of countries like Japan, Germany and Italy, which are dependent on other countries for their supply of cotton fibre. These countries are anxious to replace it with home-made substitutes.

TABLE II.

WORLD PRODUCTION.

(In million pounds)

	Art. Silk Yarn	Staple Fibre
1925 ...	185	Nil
1930 ...	417	6.1
1935 ...	932	139.9
1939 ...	1125	1025

The increase in production of artificial silk yarn and staple fibre is more vividly expressed in the graph (Fig. I).

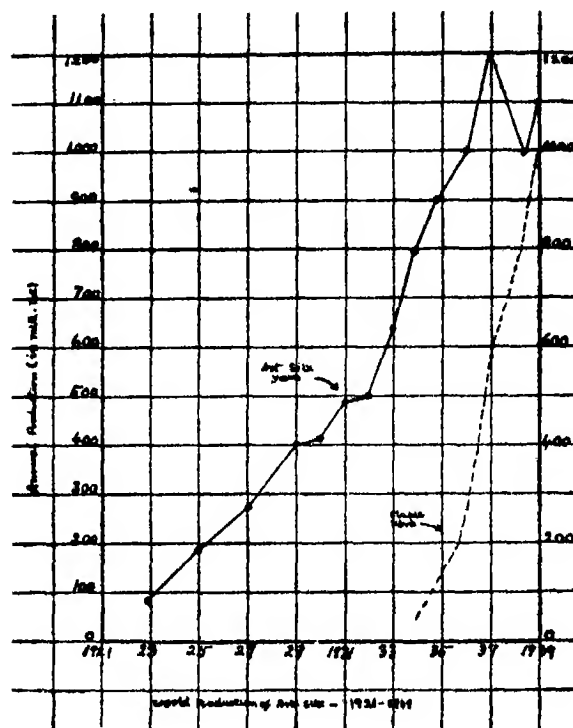


FIG. I.

The staple fibre, though originally developed as a substitute for cotton, is now finding a wide application. It is no more a mere competitor for cotton but may be considered a supplementary fibre. This view will find confirmation in the increased production of U. S. A. and Great Britain.

PRODUCTION IN U. S. A.

(In million pounds)

	Art. Silk Yarn	Staple Fibre
1930 ...	127	0.3
1935 ...	257.6	4.6
1939 ...	331.2	58

In fact, the consumption of staple fibre in U. S. A. is considerably more than its production. It has been estimated that 47 million lbs. were imported in U. S. A. in 1939 to meet the country's requirement. It is expected that the production of

staple fibre will increase more in near future in spite of the country's huge resources of natural cotton fibre. But in India, it is often argued that the development of artificial silk industry would be detrimental to the cotton industry. It is to be remembered that the synthetic fibres are now used to improve cotton textiles and for artificial silk industry the Indian short-staple cotton fibre will be a raw material. This use will not only increase the demand for Indian cotton but will also reduce variations in the prices of cotton considerably. A similar argument was heard some time ago in England with regard to coal, where it was believed that the enormous increase of internal combustion engines based on liquid fuels would reduce the demand for British coal and thus endanger the prosperity of the British coal industry. In practice however the enormous demand for liquid fuels led to the invention of processes for making oils from coal, thus creating more demand for coal which provided employment to a large number of workers. The apprehension entertained in some quarters in India regarding the future of cotton as a result of the development of the artificial silk industry will prove equally groundless.

The necessity for development of artificial silk industry in India will be evident from the fact that this country imported not less than 4'87 crores of rupees worth of artificial silk goods in the year 1937-38 and this figure is increasing year by year. Almost the whole of Indian import came from one single country, namely Japan, which supplies the product at a very cheap rate.

IMPORT OF ARTIFICIAL SILK IN INDIA, 1937-38.

	Total quantity.	Japan's share.
Art. silk yarn ...	31·6 mill. lbs.	28 mill. lbs.
Piece-goods ...	89·7 „ yds.	88·5 „ yds.
Art. Silk-mixed piece-goods ...	16·1 „ yds.	15 „ yds.

RAW MATERIALS FOR MANUFACTURE

The principal raw materials for the manufacture of artificial silk are (i) purified cotton, and (ii) wood cellulose. The former is used for the manufacture of the acetate silk and the latter is generally used for viscose rayon, purified cotton also having a limited use. The cellulose for the purpose must have certain definite characteristics and is generally obtained by

the sulphite process from certain species of wood, such as spruce, hemlock, balsam and occasionally certain species of firs and pines. Economic reasons demand that the above species of wood should occur in easily accessible areas so as to be hauled by waterways. As these species are being used up and their accessibility is becoming more and more difficult, improved methods of haulage are being introduced in western countries. In India suitable species are known to occur in abundance in difficultly accessible Himalayan regions. Introduction of modern scientific methods of haulage may however make them available for industries in this country.

It is interesting to note that Japan, the largest producer of artificial silk, meets her requirement of rayon pulp largely by importation from U. S. A. and Canada. In recent years however Japan has been rapidly increasing her domestic production with a view to self-sufficiency. The Japanese Government has planned a four-year programme for increasing pulp production and the country is expected to become independent of foreign supplies by 1942. Investigation into indigenous materials has been intensified and the imported pulp has already been replaced partly by the country's own raw materials. Several species of coniferous and foliaceous wood, rice and wheat straw, stems and pods of soya beans, bagasse and reed are being successfully used for the manufacture of pulp. Similarly Italy has been utilising Abyssinian bamboo, hemp and straw for the manufacture of rayon pulp. In U. S. A. intensive research has made southern pines available for the rayon industry. In India, our forest resources in easily accessible regions and large stocks of agricultural by-products, which are now wasted, should be explored for the purpose. Some of these materials are known to have short fibre-lengths and high ash-content. Fibre-length, which is an important characteristic for paper-pulp, may not be of equal significance in the manufacture of artificial silk, in which the cellulose has to be dissolved before spinning. The ash-content may also be reduced by suitable treatment. Apart from certain species of wood, the following materials may prove promising sources of rayon-pulp in India :

- (i) Short-staple cotton,
- (ii) jute, hemp and barks of certain plants,
- (iii) bamboo,
- (iv) rice and wheat straw,
- (v) sabai and elephant grass,
- (vi) bagasse, and
- (vii) reed.

The rayon pulp should have high alpha-cellulose, a proper viscosity in solution, low ash, easy bleach and other suitable characteristics. But the best test for the suitability of a raw material is its actual conversion into fibre and subsequently testing the properties of the fibre obtained.

MANUFACTURING PROCESSES

Though there are several processes in the field, only two processes are in extensive use, *viz.*, the viscose process and the acetate process. The former uses purified wood-cellulose as the chief raw material, while the latter uses purified cotton. Viscose rayon is reputed to be cheap but the cost of production of acetate silk is now being rapidly reduced by large-scale manufacture of solvents and improved methods of acetylation. The difficulties of dyeing the acetate silk have been largely overcome by the introduction of new dyes placed in the market by manufacturers. On the other hand, the viscose process is also undergoing rapid improvement. The introduction of stretch-spinning in a strongly acid bath has considerably improved the tensile strength of viscose yarn in both dry and wet state. Stretch-spinning is also being introduced in the acetate silk industry. A short description of the two processes is given here.

VISCOSE PROCESS

The preparation of a uniform raw material is of the greatest importance. For this purpose, cellulose is obtained from wood and other raw materials by freeing it from lignin, resin and other accompanying impurities. The sulphite process, which is usually used for the purpose, consists in digesting disintegrated wood with an aqueous solution of calcium bisulphite under pressure at temperatures varying from 120° to 150°C. The excess of sulphur dioxide is re-used and the sulphur in the waste sulphite liquor is recovered as far as possible. The cellulose pulp is washed, bleached and blended to obtain a uniform raw material and then compressed into sheets of standard size which are soaked in caustic soda under closely controlled conditions. The excess of alkali is pressed out and the alkali-cellulose is "aged" by standing for a definite time at a constant temperature. The material is then disintegrated in a shredding machine, treated with carbon bisulphide in rotating drums and again allowed to stand or "ripen". The ripened xanthate is then dissolved in water or dilute alkali and the impurities are settled out by standing. The solution is then re-aerated and passed through filters into spinning jets immersed in coagulating bath.

The spinning jets are made of plates having a number of tiny holes, 25 or more, through which the

clear viscose solution is forced under a pressure of over 200 atmospheres. The liquid passes downwards through the jets into spinning boxes which contain dilute sulphuric acid with sodium bi-sulphate and other additions. The viscous solution coagulates here into yarns, the acid combines with the alkali, decomposes the xanthate with the production of CS_2 and H_2S and regenerates the cellulose. The carbon disulphide and sulphuretted hydrogen are recovered from the vapours of the spinning box. The coagulated fibres are passed over guides through the spinning bath into collecting bobbins and are later bleached, twisted and reeled. In the centrifugal or pot-system of spinning, the yarn is given a twist of 2.5 per inch as it collects in rotating spinning boxes.

The properties of the yarn may be modified by adding certain ingredients, either in the xanthate solution before spinning or in the coagulating acid bath. Titanium dioxide has been used to reduce the glaze (delustering), while glucose in the coagulating bath makes the fibre stronger and smoother. The yarn is also subjected to after-treatment in order to increase its strength, appearance and water-resisting properties.

The properties of solution of cellulose vary considerably with the nature and history of raw materials. Small variations in the treatment of cellulose at different stages have profound effect on the properties of cellulose solutions. Great care is therefore necessary at every stage of manufacture to ensure that constant conditions are maintained.

LILIENTFELD'S MODIFICATION

Lilientfeld obtained yarns much stronger than ordinary viscose rayon by using a strongly acid precipitating bath and stretching the filaments considerably between the spinning jets, the yarn guide and the collecting device. This stretch spinning is being widely adopted not only for viscose but also for acetate rayon. Certain other modifications, such as cooling the alkali cellulose in shredders, treating the same with large excess of carbon disulphide, controlling the temperature, and composition of the coagulating bath and after-treatment of the yarn, are known to improve the quality of the fibre considerably.

STAPLE FIBRE

The viscose process of spinning is generally used for the manufacture of staple fibre, using a very large number of jets or openings in each plate. The yarns coming out from these jets are coagulated in

the usual manner, collected in a bundle and cut into short lengths of $1\frac{1}{2}$ to 2 inches. These are blown into a fluffing machine, packed into bales and used very much like cotton.

ACETATE PROCESS

The acetate silk is usually prepared from carefully purified and dried cotton which is soaked in glacial acetic acid. The mass is then dipped in an acetylating bath containing 20 to 30 times its weight of acetic anhydride and glacial acetic acid in the presence of certain substances, usually sulphuric acid, chlorosulphonic acid or perchloric acid. These substances, commonly called catalysts, accelerate and complete the acetylation into tri-acetate of cellulose. The cellulose gradually dissolves in the bath kept at the ordinary or slightly elevated temperature and when the acetyl content has reached the maximum, i.e., about 62%—an operation which takes many hours—the acetylating bath is diluted with a small quantity of water sufficient to convert the anhydride into acetic acid. A little sodium acetate or other sodium salts are then added and the solution heated so as to hydrolyse the tri-acetate under careful condition until the acetyl content is reduced to 55 to 57%. The radical of the catalyst which may have entered the cellulose molecule is removed in the process. It is only after this careful hydrolysis that an acetone-soluble product is obtained. It is interesting to note that breaking off the acetylation process as soon as the desired acetyl content is reached (55 to 57%) does not yield an acetone-soluble product. When the hydrolysis has proceeded to the desired limit, the whole mass is poured into excess of water to precipitate the cellulose-acetate which is washed, dried and dissolved in acetone mixed with other solvents before spinning.

The above method of preparing cellulose acetate has the disadvantage that large quantities of glacial acetic acid and acetic anhydride remain in the form of diluted acetic acid, which has to be concentrated before it can be used again. In recent times however methods have been developed for acetylation without destroying the fibrous structure of the product which may be centrifuged, and the acetylating liquid recovered for further use. The fibrous product is washed, dried and dissolved in acetone or chloroform for spinning.

The solution in acetone must be a viscous liquid containing 7 to 8% of the ester. It is de-aerated and forced through filters into jets similar to those used in the viscose process. The spinning is downwards—the solution is extruded into a cylinder or chamber usually 16 to 20 ft. in height. A current of warm air

is drawn through the chamber to take away the volatile solvents and coagulate the solution into yarns which pass over guides through apertures in the side of the chamber near its bottom and wound on spools. The speed of winding is carefully adjusted to subject the filament to tension and thus diminish the cross-section. About 2.5 twists per inch are given to the yarn as it collects in the spool. The air carrying the solvent vapour comes out at the top of the chamber and is drawn through absorbers where the solvent is recovered.

COST OF PRODUCTION

On account of the cheapness of the process, viscose rayon is extensively manufactured in various countries. Japan, the principal producer of artificial silk yarn, follows the process almost exclusively. In U. S. A., however, an appreciable amount of acetate silk is manufactured. The production of the acetate and of the solvents on an extensive scale has been organised in that country and as a result the cost of production has been steadily coming down. In India where the solvent industry is practically non-existent and the cheaper products are likely to be more in demand, the viscose process seems to have a brighter future. The following materials will be necessary for the production of *one ton* of artificial silk:

1.2	ton cellulose,
1.8	ton caustic soda,
0.46	ton carbon disulphide,
1.5	ton sulphuric acid,
2.0	ton bisulphate of soda,
1.6	ton sulphate of magnesium, zinc and glucose,
0.05	ton bleaching powder,
0.04	ton lubricating oil,
6 to 8	tons coal, and
30 to 40	sq. yds. filter cloth.

As part of the chemicals used can be recovered and their cost varies in different places, no attempt is made here to estimate the total cost of production. It may however be stated that power consumption is considerably low in larger installation and as a result only larger units can operate economically. As large quantities of sulphur and its derivatives are required in the process, it is desirable to develop indigenous sources of sulphur. Various western countries are producing large quantities of sulphur as a by-product and have become self-sufficient with regard to this important raw material. Even if we

have to depend temporarily on foreign supplies of sulphur, this argument need not be used against developing this important industry in India. Japan has built up a large and prosperous artificial silk industry though she is largely dependent on foreign supplies of the most important raw material, *i.e.*, cellulose.

The average cost of production in Japan has been estimated at 0.73 Yen (about -/9/- as.) per lb. for artificial silk yarn, made up as follows:—

Cellulose	...	...	0.25	Yen
Caustic, sulphuric acid and other chemicals	...	...	0.145	„
Coal and power	...	...	0.08	„
Labour	...	...	0.055	„
Packing, sale, freight and repair	...	...	0.12	„
Tax, depreciation and interest	...	...	0.08	„

Total ... 0.73 Yen

It is interesting to note that though the cost of production in Japan is -/9/- as. per lb., the C. I. F. price in Calcutta for Japanese goods is As. -/10/4 only. In U. S. A. the price of artificial silk yarn is considerably higher, *i.e.*, 60 cents or Re. 1/12/- as. per lb. The low cost of Japanese goods is due to Government subsidy, low cost of labour and efficient trade organisation. Chemicals are supplied by the Government at reduced prices, demonstrations and propaganda work are carried on at Government expense and legislative action is undertaken by the Government to increase internal consumption of synthetic fibres by enforcing their admixture with cotton and wool.

NEED FOR RESEARCH

The synthetic fibre industry has made tremendous progress in course of the last 20 years as a result of intensive researches in the field of cellulose chemistry and chemical engineering. Today the progress is still greater than before and the climax is still far from being reached. In contrast with this progress, the textile industry is, on the whole, standing still. The synthetic fibre industry is essentially a chemical industry while the textile is a process industry, in which knowledge of fundamentals, though useful is not essential. Our industrialists, from their experience of cotton textiles are inclined to look upon research as an unnecessary and costly luxury. They often favour a 'wait and see' policy, so that the necessary research and improvement may be made at the expense of foreign countries and India may take advantage of them by simply paying for a few foreign experts. This may, to a certain extent, be true for a process industry like cotton and wool textiles; but it is far from true in the case of larger chemical industries. Western countries have not built up their chemical industries—the dye-stuff, the synthetic fuel, the synthetic fibre and other large chemical industries—without constant research and progress. In addition to fostering research in universities and other educational institutes, special research institutes have been established in various countries with the object of fostering research on cellulose and its products. Only recently, Japan has established a special cellulose research institute at Kanagawa at a cost of 2.5 million Yen (20 lakhs of Rupees), in spite of numerous other organisations already engaged in researches on cellulose. It is time that India should take all necessary action for developing a synthetic fibre industry in this country. Already in European countries, large concerns with extensive financial resources have interested themselves in the manufacture of artificial silk and the success of smaller and newer concerns will gradually become increasingly difficult. Our attempts in this direction should be made in time before it is too late.

MEDICINE & PUBLIC HEALTH

Medical Stores Supplies for India

MANY problems affecting medical supplies to the Army were considered at the third meeting of the Drugs Supplies Committee, now called the Medical Stores Supply Committee, held recently under the chairmanship of Lieut.-General G. G. Jolly, I.M.S., Director-General, Indian Medical Service. Samples were shown of emetine hydrochloride, apomorphine hydrochloride, acriflavine and dried blood plasma made in India under schemes of investigation fostered by this Committee in close liaison with the Board of Scientific and Industrial Research.

To combat shock through loss of blood, blood transfusion is largely used in modern medicine. Such blood is difficult to obtain in quantity for the treatment of the wounded in the field and so other methods are being carefully considered. One of the most successful and promising of these methods is the use of dried blood plasma. Blood to which sodium citrate has been added to prevent coagulation is allowed to settle and the clear liquid drained off. This liquid is dried in vacuo to a granular powder and packed aseptically in containers. Before use it is made into a solution with sterile water and given to the patient in the same manner as a blood transfusion. The sample of dried blood plasma, the first to be made in India, has shown the possibilities of its manufacture in India.

The production of emetine hydrochloride which is still required for the treatment of amebic dysentery is closely associated with the growth of *Ipecacuanha*. This drug grows wild in the forests of South America but is more and more difficult to obtain. The plant has been demonstrated to grow well in Mungpoo, Bengal, and the question of encouraging its cultivation in India is under consideration.

Much progress has recently been made in Travancore, Bombay and Madras in the development of fish liver oil schemes for supplying India with substitutes for cod liver oil. The essential factor in these oils is their content of vitamin A and vitamin D. As the shark liver oil has ten times the vitamin A content of cod liver oil it forms a valuable source of

vitamin A. This oil however is lacking in vitamin D so that it is necessary to add this vitamin to it. Vitamin D is reported to have been made at the Indian Institute of Science at Bangalore.

Location of Tuberculosis Clinics

THAT if a tuberculosis clinic is to be of maximum benefit, it should be situated in, or as close as possible to, a thickly populated area, is the unanimous opinion of the committee of experts recently appointed by the Tuberculosis Association of India at the instance of the Government of India to consider what conditions should govern the selection of sites for such clinics and whether any particular precautions were necessary in the case of clinics situated in populated areas. The committee were also of the view that no particular conditions are necessary regarding the distance of a well-conducted clinic from the nearest house. They recommended, however, that if a clinic is located in a part of a building used for other purposes, the clinic should have a separate entrance.

Ascorbic Acid Deficiency and Cellular Blood Constituents of Guineapigs

SIGNAL (*Proc. Soc. Exp. Biol. and Med.*, 42, 163, 1939) observed that in anaemia accompanying scurvy in guineapigs, there was a progressive decrease in the haemoglobin and red blood corpuscles and a slight increase in the white blood corpuscles. He also observed that when guineapigs receiving 3 mg. of the vitamin C per day were given subcutaneous injections of diphtheria toxin, there was less disturbance in their blood cell count than in similarly treated animals receiving 0.5 mg. of the vitamin.

S. B.

Sulphathiazole and Sulphamethylthiazole in Gonorrhoea

2-SULPHANTILYL aminopyridine known as sulphapyridine has been found to be very useful in combating coccal infections. Recently two thiazole deriva-

tives of sulphanilamide, 2-(p-aminobenzene-sulphonamido) thiazole, known as sulpha-thiazole and 2-(p-aminobenzene-sulphonamido) 4-methylthiazole, known as sulphamethylthiazole have been used by Lloyd *et al* (*Lancet*, 2, 186, 1940). As compared to sulphapyridine, sulphathiazole has been found by them to be equally effective in its therapeutic action. Sulphamethylthiazole is less efficient and the action is very slow. The patients tolerate the drugs very well.

S. B.

Capillary Fragility and Vitamin P.

BORBELY (*Munich. med. Wschr.* 77, 886, 1930) observed that syphilitic patients receiving injections of salvarsan often suffered from increased capillary fragility *i.e.*, the capillary walls burst as a result of the application of lesser amount of either positive or negative pressures than normal. Scarborough and Stewart (*Lancet*, 2, 610, 1938) observed that cases of purpura occurring as toxic manifestation of anti-syphilitic therapy with arsenic and bismuth had diminished capillary resistance and the capillary resistance in these cases was raised by the administration of vitamin P. Horne *et al*, (*Lancet*, 2, 66, 1940) have shown that redness and dermatitis occurring as toxic manifestations of antisyphilitic therapy are also associated with increased capillary fragility and these cases improve after administration of vitamin P. Vitamin C is without any effect.

S. B.

Diarrhoea and Gastrointestinal Absorption of Ascorbic Acid

ABT and Farmer suggested (*J. A. M. A.*, 111, 1555, 1938) that under certain pathological conditions the absorption of ascorbic acid from the gastrointestinal tract is abnormal. Meyer and Dobinson observed (*Ann. Pediat.*, 152, 283, 1939) that when infants suffering from diarrhoea were supplied with massive doses of ascorbic acid per mouth, the blood ascorbic acid was low and the urinary excretion was diminished. When the vitamin was administered by injection, a rise in the blood ascorbic acid and increased elimination of urinary ascorbic acid were noted. Abt, Farmer and Topper (*Proc. Soc. Exp. Biol. and Med.*, 43, 24, 1940) determined the ascorbic acid content of the faeces of infants by the method of Chinn and Farmer (*Proc. Soc. Exp. Biol. and Med.*, 41, 561, 1939). Ascorbic acid was found to be excreted in smaller amounts in the stools of normal infants. When these infants were purged by means of cathar-

tics large amounts of orally fed ascorbic acid were excreted in the faeces. This shows that the intestinal tract fails to absorb ascorbic acid in such a condition and explains the low blood level and diminished urinary excretion of ascorbic acid in infants suffering from diarrhoea.

S. B.

Effect of Insulin on Plasma Level and Excretion of Ascorbic Acid

RALLI and Sherry observed (*Proc. Soc. Exp. Biol. and Med.*, 43, 669, 1940) that when insulin was injected in normal dogs there was a fall in the plasma concentration and urinary excretion of ascorbic acid. The effect persisted for about 7 hours after which the plasma level and urinary excretion of the vitamin returned to normal. The fall in the blood level and urinary excretion of ascorbic acid was very sharp when insulin was injected into depancreatized dogs. This effect of insulin, however, could be overcome by intravenous injection of glucose.

S. H.

Recovery of Ascorbic Acid from the Urinary Bladder

IN assessing the ascorbic acid nutrition by urine analysis, the question may arise as to the loss of the vitamin, if the urine is retained in the urinary bladder for a considerable time. Sherry and Friedman, however, observed (*Proc. Soc. Exp. Biol. and Med.*, 42, 707, 1939) that after instillation of ascorbic acid in amounts varying from 0.5 to 30 mg. into the urinary bladder 92-107% could be recovered in the urine after periods of 1-5 hours. Therefore they have concluded that practically no loss of the vitamin takes place inside the urinary bladder.

S. B.

Announcement

THE 3rd All India Obstetric & Gynaecological Congress will be held this year in Calcutta from the 27th to the 30th December 1940, both days inclusive. The subjects for discussion are: (i) Anaemia of Pregnancy; (ii) Functional Uterine Haemorrhage; and (iii) Maternity & Child-welfare. Detailed information may be obtained from the Jt. Hon. Secretaries, Bengal Obstetric & Gynaecological Society, 91B, Chittaranjan Avenue, Calcutta.

Sugar

T. S. TIRUMURTI,

Principal, Stanley Medical College, Madras.

THE importance of sugar as a food is now well recognised. Several different varieties of sugar are known. The two main groups are (i) disaccharides, the chief examples of which are cane-sugar, beet-sugar, maple-sugar, malt-sugar and milk-sugar; and (ii) mono-saccharides, such as grape-sugar, fruit-sugar and invert-sugar, which is a mixture of grape-sugar and fruit-sugar. The technical names applied to these sugars are as follows: (i) sucrose or saccharose is cane, beet or maple-sugar; (ii) maltose is malt-sugar; (iii) lactose is milk-sugar; (iv) glucose, grape-sugar; (v) laevulose, fruit-sugar and (vi) invert sugar, a mixture of glucose and laevulose. Of the above sugars, cane-sugar is the most familiar of all. It is mainly derived from the sugarcane. When derived from sources other than the sugarcane, special names as beet-sugar or maple-sugar are usually given to it. But, from the chemist's point of view, beet-sugar or maple-sugar is indistinguishable from the sugar, derived from the sugarcane.

Sugar, derived from the sugarcane, has been in use in the world as a food for many ages, but it is only within comparatively recent times that it has been manufactured cheaply enough to take an important place in ordinary diets. It may be of interest to know that the sugarcane was known in China 2,000 years before it was used in Europe. It appears to have been known at more or less the same time in India as well. It travelled westwards later. The Greek physicians, several centuries before the Christian era, spoke of sugar under the name of 'Indian salt'. It was called 'honey made from reeds'. In the 14th or 15th century, the Indian sugarcane was cultivated in North Africa and later in the West Indies and Brazil. It is reported that sugar was first used in Great Britain in 1319.

The history of beet-sugar is interesting. In 1747, Marggraf, a chemist of Berlin, discovered that beets, with other fleshy roots contained crystallizable sugar, identical with that of the sugarcane. In 1796, his pupil, Achard, is said to have erected the first manufactory for beet sugar. Only 2 to 3 per cent. of sugar could be extracted by the methods then in use. Therefore, the amount was too small for making the manufacture of beet-sugar a commercial success. A great stimulus was given to the manufacture by

Napoleon in 1806. He granted State sugar bounties and the methods were rapidly improved, especially in France. By scientific investigation, a beet was gradually developed, having a large percentage of sugar.

It is not necessary in this connection to consider the other forms of sugar, as they are not of such commercial interest as sugar from the sugarcane and the beet. To the ordinary consumer, beet-sugar is hardly distinguishable from the cane-sugar. To the chemist, the two are really identical. The manufacturers say that for some purposes, sugar derived from the cane is preferable, e.g., in the manufacture of fruit-syrups, because cane-sugar is said to be less liable to fermentation.

I need not deal with the methods of preparation of raw sugar and the methods of purification and the process of refining. It may suffice to say that most of the sugar manufactured and sold in the world today is only refined sugar. Sugar, which was not so long ago a rare luxury, occupies today a very prominent position in the diet of a civilised man.

* It has been stated by a writer in the *British Medical Journal* (1, 119, 1901) that the difference between cane-sugar and beet-sugar is not a chemical, but a physiological one—a question of taste and flavour—and that it is similar to that between silent spirit faintly coloured and genuine Scotch whisky. There is no evidence for the statement that beet-sugar is more injurious to health than genuine cane-sugar, though there are evidences to show that genuine cane-sugar is of higher value as a food and as an article for therapeutic purposes. While the diet of the modern civilized man appears to be a great improvement on that of his ancestors, his habit of consuming large quantities of concentrated refined sugar, is an item on the debit side, because such sugar is deficient in nearly all the most valuable food factors. It has been shown that 'molasses' or treacle, a residue separated from sugar in the process of manufacture, is richer than sugar in organic elements, particularly—iron. Its high iron-content gives 'molasses' a peculiar importance in the diet of the people of Labrador.

In western countries, the consumption of sugar has increased from a few lbs. per person per

year a little over a century ago, to upwards of 100 lbs. per capita today. This increase is not uniform as regards individuals; it is however true to state that during the past 25 years the Germans, the Americans, the English and other nations are consuming a large proportion of refined and manufactured food products, including sugar. Unfortunately, the proportion is sometimes so large as to make their dietaries frequently of poor quality in respect to several nutrients—mineral elements and vitamins.

The following figures compiled by the International Institute of Agriculture will be of interest, because it gives us an idea as to the per head consumption of sugar per year.

PER HEAD CONSUMPTION OF SUGAR PER YEAR

(Period: 1930-34).

	Lbs.		Lbs.
Austria	61	Netherlands	68
Belgium	62	Norway	70
Bulgaria	10	Poland	23
Czechoslovakia	56	Rumania	12
Denmark	120	Sweden	95
Finland	51	Switzerland	98
France	57	United Kingdom	119
Germany	52	Canada	95
Italy	18	United States	103
India (1938-39)*	25.9	Australia	107

From the figures it will be seen that in all the progressive countries in Europe and America, there is a large amount of sugar consumed. Denmark leads in this matter and in the United Kingdom, the United States and Australia there is more than 100 lbs. per head consumption of sugar. Bulgaria and Rumania are the lowest in the scale.

As for India, Dr W. R. Aykroyd in his *"Note on the Results of Diet Surveys in India"*, states, "the sugar intake of most of the rural rice-eating groups was nil or negligible. The Industrial groups in Bihar consumed under 1 oz. of sugar daily. The intake of the families in Delhi province and of the Bombay workers was a little above this level. In Southern India, consumption of sugar and jaggery is in general very small. These figures suggest that the recent increase in sugar production in India has not yet been reflected in a substantial intake of sugar on the part of the poorer classes."

The cheapness of sugar is a development of recent years. It can hardly be without far-reaching effects on national health. It tends to make us

consume more carbohydrate and less fat, for fat is always a dear form of food. Sugar is more easily absorbed and oxidised. It is more rapidly burnt up in the body than fat. On that account, it is a more efficient protein-sparer than fat. Sugar has now become one of the cheapest of fuel-foods. "The cheapness of sugar has a favourable influence on the health and growth of children, for it ensures them in ample supply of the body-fuel, which they so much need, and which the dearthness of fat is apt to make unattainable. It has the advantage, too, of being a form of fuel, which few children are likely to refuse, and that is far from being true of fat." Though from the standpoint of nutrition, an increased consumption of sugar is not highly important, there can be no doubt as to its desirability.

It is as a muscle food that sugar is of special importance. Carbohydrates are the chief source of muscular energy. Sugar being a variety of carbohydrate which is most easily and rapidly absorbed, fulfils this function better than any other form of carbohydrate. The English give sugar to race-horses. To Swiss guides and Arctic explorers, the value of sugar as food has long been familiar. Athletes have known the value of sugar in lessening muscular fatigue. Just before the start of the famous annual Oxford-Cambridge Regatta, each player partakes of a spoonful of brown-sugar to lessen the effect of physical fatigue. The administration of sugar delays the onset of fatigue and the subsequent effects are quickly removed. It has been shown that the addition of sugar to diet increases the power of doing work and lessens exhaustion. There is a considerable evidence in favour of the free use of sugar in training and during the performance of hard muscular work, such as, rowing, running and all vigorous games like football, hockey, etc. The men of the German Army have been reported to carry sugar as well as first-aid dressings with them, so that in case of unexpected movements, where the Commissariat fails, they can undergo considerable muscular exertion on sugar alone. Alpine climbers find sugar more sustaining under the severe strain to the heart on account of the climbing. The above facts have been adduced just to show the important part played by sugar in the expenditure of muscular energy. It is no wonder therefore that the per capita consumption of sugar in the rich progressive industrialized countries in Europe and America is very large, as compared with the amount consumed per head in a poor and industrially very backward country like ours.

The ingestion of cane-sugar has a specific action on the nutrition of the musculature of the heart. The value of glucose as a heart-tonic is now widely appreciated, even by the lay public. Dr Arthur Gordon

* From the *Indian Sugar Industries Annual*, page 92, which is the only source available at present. Of this consumption of sugar in India of only 25.9 lbs. per capita during the year 38-39, refined sugar is only 5.7 lbs. whereas unrefined gur sugar is 20.2 lbs. per head.

in his book on "*Cane-Sugar and Heart Disease*", has laid special stress on the value of cane-sugar in various diseases of the heart, in conditions of valvular disease, in malnutrition and degeneration of the heart muscle. The rationale of the treatment by means of the ingestion of cane-sugar is explained by him in great detail in the above publication. In diseased conditions of the heart he administered 4 to 10 ozs. of sugar per day for a long period.

It is very interesting, however, to note his observation gathered from long experience that the best kind of sugar is the one from sugar-cane. He also observes that sugar from the sugarcane acts beneficially on the heart musculature, where the sugar from the beet fails. A number of clinical cases are quoted in support of this contention. He considers that the difference is something like that found between hand-pounded rice and mill-polished rice. He suggests that there might be an 'activator' in the sugar from the sugarcane, which did not exist in sugar from the beet-root. Probably, the activator is destroyed in the process of refining the raw cane sugar. An officer of the Indian Medical Service is said to have obtained much success in the treatment of heart disease among the poor patients in India by giving the ripe sugarcane to chew. There is evidently something in sugarcane sugar, which is not present in beet sugar. Is it of the nature of a 'co-enzyme' or 'activator', or what? It is not inherently impossible that there may be a factor in cane-sugar, which is not present in beet-sugar. It is also interesting to note that it is the experience of bee-keepers that the bees thrive, when fed with the syrup made with West Indian sugar, whereas the bees deteriorate and may contract disease and die, when fed on beet-sugar syrup.

Dr Goulston is of opinion that apart from the use of cane-sugar in the treatment of heart diseases, it is very useful even in the prophylaxis of heart disease. He hazards the opinion that if more sugar derived from sugarcane and less sugar from the beet

root were consumed, we would soon find it a satisfactory means of prophylaxis of various kinds of heart disease, except those due to congenital defects.

Nadakarni, in his book, "*The Indian Materia Medica*", describes the various preparations made from the juice of the sugarcane and described by the old Sanskrit writers. He also describes the various therapeutic uses to which sugar is put. He states that three American scientists have, as the result of exhaustive biological experiments, proved that cane molasses are far richer in vitamin B, than either beet molasses or sorghum. The different therapeutic applications and uses of the various forms of sugar described in ancient Sanskrit and other texts have not been investigated into. The laxative, diuretic, aphrodisiac, preservative, bactericidal and other properties are mentioned for different forms of sugar made from many species of sugarcane. Unrefined and under-refined sugar, probably, has some virtues, which yet remain uninvestigated.

It is, therefore, a matter for consideration whether, after all, it is not desirable to give up the complete refining of sugar and to popularise the use of brown sugar and other forms of raw sugar in the place of the white sugar, especially in a population, whose diet is miserably poor not only in the matter of essential foodstuffs, but also in the various vitamins and mineral contents, which go to make a well-balanced diet, and which mean so much for the active physical health for a nation which wishes to be progressive with the rest of the nations in the world. There is no greater example for a search of this kind than in brown bread vs. white bread, and hand-pounded rice vs. mill-polished rice, and white flour vs. whole grain flour. Attention may well be directed not only to an investigation into raw or brown sugar vs. white or refined sugar but also to a propaganda for increased consumption of the indigenous sugar from the sugarcane and the prevention of the import of foreign beet-sugar into India.

Research Notes

Synthesis of Factor V from Nicotinic Acid in Vitro by Human Erythrocytes

Henry J. Kohn and Raymond Klein (*Jour. Biol. Chem.* 135, 685, 1940) have shown that the incubation of defibrinated human blood with nicotinic acid increases the factor V content of the blood cells. Factor V is the factor necessary for the cultivation of *Hemophilus parainfluenzac*. Of known compounds only di- and triphosphopyridine nucleotide can serve as factor V.

They along with Axelrod, Gordon and Elvehjem who recently confirmed the synthesis *in vivo* believed that the synthesis occurred in the erythrocytes because the factor V content of the normal blood is practically confined to them. But Vilter and Spies, although able to confirm the synthesis *in vitro* by blood cells, state that "... it seemed that the red cells stored and carried the enzymes instead of performing the synthesis."

Salts in the medium of synthesis and the physical conditions markedly affect the synthesis of factor V by erythrocytes. The synthesizing ability of the cells is greater in Ringer phosphate solution containing glucose than alone or in sodium chloride solution.

On the other hand, the presence of oxalate in the medium, rough handling of cells and too frequent passage through capillary pipettes are reported to diminish the synthesis.

P. K. S.

Some Factors Influencing the Oxidation of Alanine by Liver Tissue

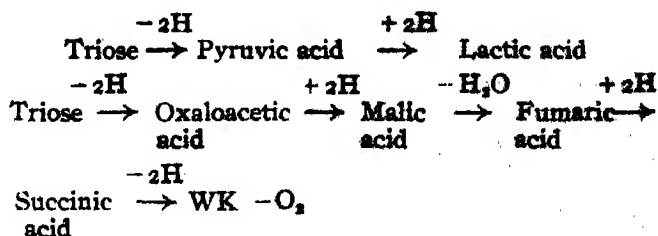
It has been shown that boiled extracts of liver contain less flavin adenine dinucleotide when the animals are fed on a diet deficient in flavin and that there is also a diminution of O_2 uptake as measured by Warburg technique. A similar diminution of O_2 uptake with alanine as substrate has also been reported.

This result has been confirmed in a paper published by R. J. Rossiter (*Jour. Biol. Chem.*, 132, 431, 1940). He has also demonstrated that additional flavin adenine dinucleotide *in vitro* caused a greater increase in O_2 uptake of liver preparations from animals receiving adequate amounts of riboflavin and concludes that the decrease in the O_2 uptake in liver preparations from animals fed on a flavin deficient diet is due to the deficiency in the *d*-amino acid oxidase flavoprotein of Warburg and Christian. His experiment proves that this deficiency can be made good by the addition of flavin adenine dinucleotide and this very fact also suggests that the protein constituent of the enzyme is present and that it is less active due to the lack of flavin adenine dinucleotide. Rossiter has also confirmed the observation of J. R. Klein that thyroid treatment causes an increase in the O_2 uptake in presence of *dl*-alanine and that there is no increase in flavin adenine dinucleotide content of boiled liver extracts of such thyroid-treated animals even if large amounts of riboflavin are given in the diet.

A. R.

Pyruvate Oxidation

Pyruvic acid occupies a central position in oxidation as well as in fermentation. It is the primary oxidation product of triose and the mother substance of lactic acid as well as of alcohol. According to Szent-Györgyi, fermentation and oxidation can be represented by the following schemes:—



In these reactions the catalytic function of the C_4 -dicarboxylic acids and of their activation by enzymes in the cellular respiration of the pigeon breast muscles and of a number of other tissues have been

well established from the experimental point of view. The extension of Szent-Györgyi's theory to include citric acid and ketoglutaric acid has been put forward by Krebs and his collaborators.

The main evidences for the occurrence of the citric acid cycle in pigeon breast muscle are as follows:—

- (i) The oxidation of pyruvate is inhibited by malonate.
- (ii) The malonate inhibition is partially overcome by the addition of fumarate, and the extra amount of pyruvate used in these conditions is in the proportion of 1 mol. of pyruvate to each mol. of added fumarate. In the presence of malonate, succinate is formed in amounts equivalent to the fumarate.
- (iii) Under certain conditions fumarate and pyruvate can be shown to form citrate and ketoglutarate.

David Henry Smyth in a paper (*Biochem. Jour.*, 34, 1046, 1940) has tried to furnish further evidence for citric acid cycle. Instead of pigeon breast muscle as worked upon by Krebs and his co-workers, he has used that of sheep's heart. He concludes that the main reactions on which the citric acid cycle is

based occur in minced heart muscle. These reactions are the malonate inhibition of oxygen consumption and pyruvate usage, the specific effect of fumarate in combining with pyruvate to form succinate in presence of malonate, the formation of citrate and ketoglutarate and the effect of the substances involved in the citric acid cycle in maintaining respiration.

This work, however, does not meet the points raised against the citric acid by Breusch (*Biochem. Jour.*, 33, 1757, 1930) nor can it throw any light on the following observations of Thomas (*Enzymologia*, 7, 97, 1939).

(a) The conversion of oxaloacetate into malate is the same in presence and absence of oxygen.

(b) In presence of arsenate the three C_4 -dicarboxylic acids *viz.*, malic, fumaric, and succinic acids are rapidly transformed into oxaloacetic acid while the same process in the case of citric acid is slow.

(c) The catalytic effect of the C_4 -acids manifests itself within ten minutes after the beginning of the experiments whereas the effect of citric acid becomes appreciable only after a delay of one hour.

Whether citric acid behaves like a metabolite or a catalyst in muscle respiration is a question of fundamental importance which confronts Krebs' theory of "citric acid cycle".

S. R.

SYNTHETIC RUBBER

In Germany and Russia the aim of research for artificially producing rubber has been to duplicate, or nearly duplicate, the properties of natural rubber; in the United States, on the other hand, the apparent objective has been to produce a product superior to natural rubber in some respect, so as to justify, in a free market, the higher cost, which is in most cases at least three or four times that of natural rubber. Recent international events have somewhat changed the American viewpoint, but have not as yet had an influence on the development of synthetic rubber in that country.

As a result of these researches, there are thirty varieties of synthetic rubber, almost all of which are at present in commercial production. The varieties are grouped in six general classes, according to chemical composition. The classes are: (1) Chloroprene polymers, (2) butadiene polymers, including copolymers, (3) organic polysulphides, (4) isobutene polymers, (5) plasticized vinyl chloride polymers, and (6) dimethyl butadiene polymers. Familiar examples of each of these types are, respectively, (1) Neoprene, (2) the German Buna rubbers, (3) Thickol, (4) Vistanex, (5) Koroseal, and (6) "Methyl rubber".

BOOK REVIEW

From Savagery to Civilisation—by M. N. Roy,
(Digest Book House, Calcutta). Pp. 240.
Price Rs. 1/8.

As mentioned in the publisher's note, the major portion of this book consists of a reprint of a series of articles contributed in the columns of the *Amrita Bazar Patrika* of Calcutta.

The historical narrative depicting the reaction of the Christian Church of Mediaeval Europe, against the memorable and epoch-making scientific discoveries, especially in the domain of astronomy has been presented in a very lucid form by Mr Roy and he deserves credit for his able and vigorous delineation of the incidents connected with the various painful episodes in the history of the development of modern science.

Mr Roy, besides being a politician, is a great votary of modern science. He does not also hesitate to look deep into the various concepts (mostly European) of god, religion, and Creation in general. He firmly believes in the unilateral progress of the human race from, what he calls, savagery to civilisation. In his opinion, the greatest contributing factor to the growth of this civilisation is the invention and development of "machines". As a matter of fact, his idea of what he considers real civilisation must of necessity be linked up with the idea of the mastery of man over the forces of nature. This mastery cannot be achieved without harnessing the physical energy of nature, for which purpose machines are absolutely necessary. In this connection he has said many things relating to the conception of god and religion which cannot unfortunately be universally accepted. Perhaps Mr Roy will ascribe this to the influence of superstition which still persists in the minds of a large majority among the human race—remnant of the savagery from which the human race has not yet been freed. Be that as it may, no one will dispute the fact that science has played and will continue to play the most vital part in regulating the progress of the human race. This word 'science' has however to be understood in its all-embracing sense, and its method will have to be applied to all branches of knowledge. Further, what has been understood as the scientific

method should not degenerate into a rigid and conventional procedure, but should continue to be a living system capable of assimilating other methods of enquiries, if they help to extend the boundary of human knowledge. In this catholic spirit we have to proceed from knowledge to knowledge. There is no discernible limit to our march, and no one can therefore—not even the greatest scientist—predict the journey's end. Whether the move is continuously forward or is caught up sometimes in cosmic or chaotic whirlpools, whether the progress is unilateral or follows a law of periodicity extending over millions of years, it is impossible for any scientist to predict with certainty. The greater the scientist, the greater is his doubt about the why and wherefore of things about him. Therefore in the domain of scientific research there is no room for dogmatism. This, it is believed, as the predominant note sounded by some of the greatest scientists of modern times. It is therefore devoutly to be wished that no scientist, however eminent he may be, ought to presume to settle once for all whether we can do without a definite concept of god or religion. That subject ought to be left alone till the flood gate of scientific knowledge opens very much wider. No one can say for what length of time mankind will have to wait for that day to arrive.

As already mentioned Mr Roy is an out and out advocate of "machines". In his opinion "machines" are the great harbingers of civilisation. "Machines", if properly organised and worked according to definite notions held by the socialists and others, will according to him lead to the salvation (in the material and even in the spiritual sense) of the human race. Unfortunately such is the perversion of nature (or providence, if there is such a thing) that calculations sometimes, —nay, very often,—go wrong. That is why there are innumerable instances around us where "machines" instead of leading to the desired end, have produced most diabolical results and have involved mankind into such fierce scientific savagery compared to which the unscientific savagery of the ancient times pales into insignificance. Of course, it is said that this is not the fault of the "machines", but of those who control them. This may be true and therefore

science should now apply itself to an investigation as to why mankind are so diabolical and why they misuse the machines after centuries of profession and practice of civilisation. Even Mr Roy will presumably admit that mankind have not really advanced from savagery to civilisation but have imbibed a certain amount of so-called civilisation and as a result, savagery, unable to exist in its naked form of by-gone ages, has hid himself in many novel disguises, such as "race superiority", "god's chosen people", "the will of providence to rule and for others to serve by the supreme decree" and so on and so forth. Therefore a better title of Mr. Roy's book would have been "Savagery and Civilisation" than "From Savagery to Civilisation".

The chapters dealing with the history and growth of socialism, though somewhat brief, will be found to be of considerable interest to laymen like the reviewer. The reviewer has derived real profit and pleasure by the perusal of these chapters. No one can have any doubt that a benevolent socialism will lead to all-round welfare and happiness of mankind. The difficulty however lies in putting the ideals of socialism into practice. Attempts have been made to introduce its principles in one form or other by violence or harsh regulations of the State. Arbitrary powers have been exercised by dictators. The methods employed have not satisfied the standards of civilisation in all cases. It is doubtful whether any country in the world has achieved any real success. Further researches are necessary and new methods have to be evolved. In carrying out these researches while science and its offsprings, the machines, should receive due recognition, the prime actor of the drama, *viz.*, the man himself should receive the first consideration. He should not be sacrificed even to the god of civilisation namely, science and machines. It has been said that man is a machine; certainly he is, but not in the narrow mechanical sense. He is quite different from a mere "mechanical" machine, if such a term is allowed. An experimenter in socialism will land himself into troubles if he overlooks this vital difference.

H. P. B.

Italian Economy and Culture—by M. Moulik. Published by Chuckervetty, Chatterjee & Co., Ltd., Calcutta, 1940. Pp. 180 and Index. Price Rs. 3.

The author of this collection of essays on "economic and social transformations" in Italy is a doctor of politics of Rome. He is already well known by his various journalistic contributions on matters relating to contemporary Europe and this volume will enhance his reputation. The twelve essays range in

variety from "Tucci, Tibet and India" to "Sibilla Aleramo's Mythical Woman".

It has required some boldness for the author to have ventured upon the release of a volume on Italy at this time. Without being propagandist, Moulik has been able to be both readable and informative. The Italy of art and sculpture, of romantic movements and cultural associations, of new trends in literature and life is pictured with considerable success. For the student of socio-economic developments in Fascist Italy there are two chapters on 'corporativism' and 'Italy since Carducci'. Moulik does not obtrude his scholarship on the reader and is not dull: his performance has merits as a literary narrative but is not meant to be either critical or comparative.

B. N. B.

Simple Experiments on Physico-Chemical Principles

—by M. L. Schroff and A. P. Srivastava. Published by the Indian Pharmaceutical Association, Hindu University, Benares, 1940. Pp. 202 with Index. Price Rs. 5 or 8s. 6d.

This book written for students of pharmaceutical chemistry is welcome in view of the growing recognition in this country of the importance of physical chemistry and colloid science in medical and biological sciences. The subject matter of the book has been well arranged and its scope has been extended fairly widely to include even some of the important advanced experiments in physical chemistry.

For the application of physical methods to chemistry and allied sciences, the student should be acquainted with the theory, and should know how to handle the relevant formulae and equations, and, last but not the least, how to enter their observations in his note book. The authors appear to have kept all these aspects in view. In describing an experiment they have lucidly discussed the underlying theory, have given the details of the apparatus necessary and pointed out the manner in which data should be entered in the note book. The book will be of great help to every beginner in practical physical chemistry.

The book however appears to have been printed rather hastily. We would be really glad to see the book with less of printers' devils which in some cases have created some confusion. For instance, on page 24 the symbol 'V' has been used for difference in velocity and also for the volume of the liquid with viscosity η . We hope these and similar points will be attended to in the next edition.

The book can also be recommended to all beginners other than students of pharmaceutical chemistry.

S. N. M.

LETTERS TO THE EDITOR

The Viscous and Electrochemical Properties of Constituents of Oil-well-drilling Muds

In this laboratory we have been studying for some time past the viscous and electrochemical properties¹ of bentonites, clays and shales of the type used in the preparation of oil-well-drilling muds.² Investigations in the Field Research Laboratories of the Burmah Oil Co., have shown that a knowledge of *pH* and buffer capacity of a drilling mud is useful in the control of viscosity and plastering power, and possibly of other properties. The relation of *pH* of clays and bentonites to their viscous and thixotropic properties has been observed

diminishes slowly up to *pH* 10, the limit to which their data extended.

The titration curves of hydrogen clays, hydrogen bentonites and their subfractions with different bases and in presence or absence of salts have been studied in this laboratory³ in some detail. These curves show a variety of features. What concerns us here is the titration curve with NaOH in the absence of salts. Dr R. P. Mitra⁴ observed that hydrogen clays and hydrogen bentonites isolated from different sources give two types of potentiometric titration curves with caustic soda. In the first type the buffer capacity shows only one minimum (called the first inflexion point) corresponding to the complete neutralisation of hydrogen ions at a definite level of affinity and one maximum at approximately the point of half neutralisation of the quantity of acid neutralised at the inflexion point mentioned above. In the second type, the buffer capacity shows two minima and between them one maximum, the curves resembling those of dibasic acids in true solution. The total acidity calculated from the first inflexion point is

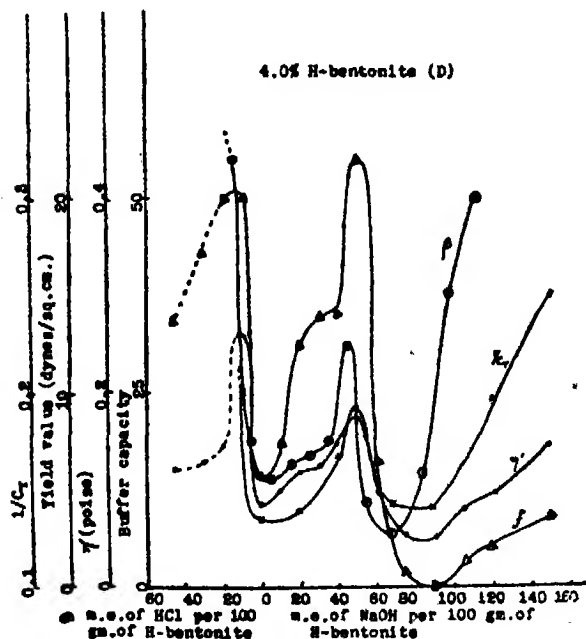


Fig. 1.

[Note: Viscosity measurements were carried out by means of a rotary viscometer.]

by several workers.⁵ Broughton and Hand⁶ found that yield value of a bentonite suspension to which increasing amounts of caustic soda are added, diminishes from *pH* 2.2 to *pH* 4, increases beyond *pH* 4 to a maximum at approximately *pH* 5 and

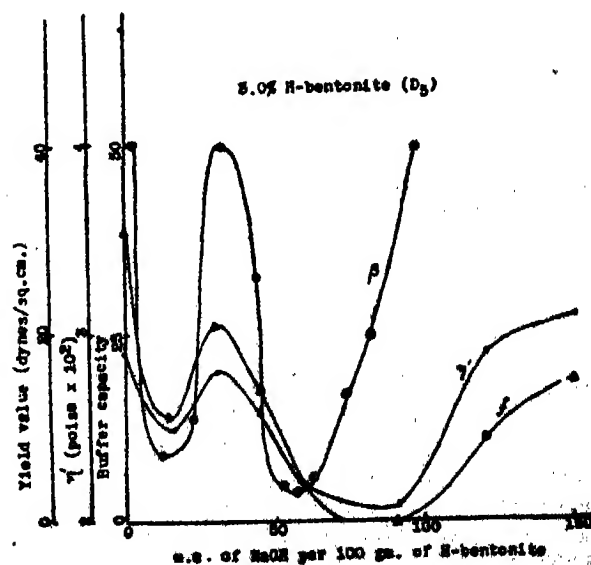
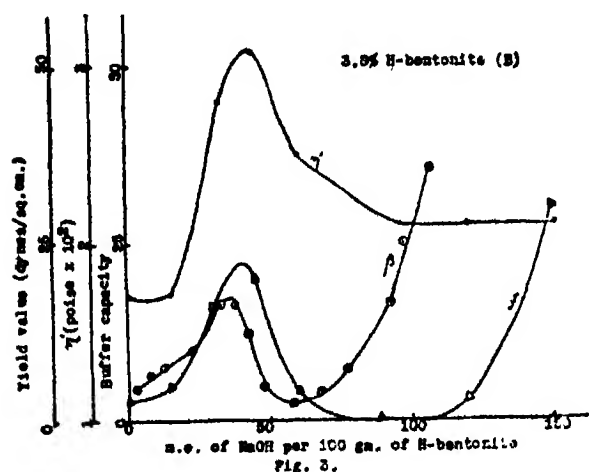


Fig. 2

[Note: Viscosity measurements were carried out by means of a capillary viscometer.]

only about ten to twenty per cent. of that calculated from the second inflexion point. Correlation of these results with observations in the Burma Oil Co., Laboratories would seem to indicate that the bentonites which give best results in the preparation and treatment of drilling muds possess the dibasic acid character. Inferior results have been obtained with what may be called monobasic acid bentonites.

Measurements made in this laboratory show that in the case of hydrogen bentonites treated with different amounts of NaOH and HCl there is a close correlation between yield value, consistency* and thixotropy on the one hand and buffer capacity on the other. Results obtained with a hydrogen bento-



[Note: Viscosity measurements were carried out by means of a capillary viscometer.]

nite isolated from the entire clay fraction of a natural Indian bentonite are given in Fig. 1 and that from a fine sub-fraction of the same bentonite in Fig. 2. The buffer capacity (β) curve in Fig. 1 shows two minima at pH 2.8 and 8.5 respectively and a maximum at approximately pH 5.5. The buffer capacity also rises steeply above pH 9.0 and below pH 2.3. The yield value (j) and the consistency (η') curves run parallel to the β -curve. The second minimum in the j and η' -curves, however, occurs at a higher pH , namely, in the vicinity of pH 10. The minimum concentrations (C_r) showing thixotropy with different amounts of NaOH and HCl have been measured and $1/C_r$ found to vary in the same way (vide Fig. 1) as the properties discussed above. In the case of what may be described as the monobasic acid bentonite a similar correlation between viscous properties and the buffer index has also been observed (vide Fig. 3).

* Consistency is the reciprocal of mobility.

The possibility of controlling properties of drilling muds by measuring the buffer index is an attractive one and further research is clearly indicated.

Physical Chemistry Laboratory,
University College of Science
and Technology,
92, Upper Circular Road,
Calcutta, 25-9-1940.

J. N. Mukherjee.
N. C. Sen Gupta.

Fields Research Laboratory,
Khodaung, Upper Burma.

A. Reid.

- ¹ Mukherjee and Sen Gupta, *Nature*, 145, 971, 1940.
- ² Evans and Reid, *Drilling Mud*, *Trans. Min. Geol. Inst., India*, December, 1936.
- ³ Houwink, *Elasticity, Plasticity and Structure of Matter*, 1937, p. 351; Freundlich, *Thixotropy*, 1935, p. 35.
- ⁴ Broughton and Hand, *Nature*, 142, 255, 1938.
- ⁵ Mukherjee and Sen, *Ind. Jour. Agric. Sci.*, 1, 189, 1931.
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- ⁶ Unpublished results by Dr R. P. Mitra.

X-ray Diffraction Halo of a Flowing Liquid

DURING the course of an investigation of the effect of an electric field on the viscosity of liquids in this laboratory, it was considered important to ascertain if the motion of the liquid had any influence which penetrated into the molecular regions affecting the molecular orientations.

At the suggestion of the author of this note X-ray diffraction halo of benzene, which in the usual stationary state gives a fairly sharp ring, was also obtained with a cell of special design through which benzene was made to flow with a velocity of about 3 cm./sec. during exposure to X-rays.

Preliminary results obtained show that the X-ray halo of flowing benzene is much more diffuse and there is marked difference in the photographic densities of the halos with stationary and flowing benzene, clearly proving that the cybotactic groupings of the molecules in the two conditions of benzene are not identical.

Experiments are now proceeding with arrangements which will permit of exact determination of the photographic densities and hence intensities of the X-ray diffraction beam with the two states of any liquid under otherwise identical conditions of exposure and development of the plate. It would be, it seems, interesting to study in this way the difference between polar and non-polar liquids as revealed

by the disturbance due to their flow, affecting their molecular regions.

As a related problem, the effect of flow of liquids on their dielectric constant, is being studied in this laboratory by Professor S. P. Prasad, whose preliminary observations have shown that a real change as compared with the value of the constant in the stationary condition of the liquids, does seem to exist.

Further details will be published elsewhere when results are ready.

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Patna, 20-9-40.

Kamta Prosad.

Magnetic Susceptibilities of some Bromides and Iodides

A number of halides have been already studied from the point of magnetic susceptibility.^{1,2} In this laboratory a detailed investigation a number of fluorides was undertaken by Mr. A. A. Chowdhury.³

We have studied the magnetic susceptibilities of the following substances using the usual Guoy Method and the relation :—

$$F_x = \frac{1}{2} (K_1 - K_2) \Delta H^2 = mg$$

where F_x = Magnitude of the force on the specimen.

 K_v = Volume susceptibility of the specimen.

$K_2 =$ " " " " " " medium.

H = Field strength.

A = Area of cross-section of the specimen.

m = Magnetic pull in gms. on the specimen.

g = Constant of gravity.

Following results were obtained :—

BROMIDES

Compound	Temperature °C	$\chi_n \times 10^4$
Ni(NH ₄) ₆ Br (Nickel hexammin bromide)	32.4	+ 11.26
CoBr ₂ (Cobalt bromide)	32.6	+ 3.96
(CH ₃ , CH ₂ , CH ₂ , CH ₃) ₄ NBr (Tetra-n-butyl-ammonium bromide) ..	32.9	+ 0.15
(C ₁₀ H ₁₇) ₄ NBr (Tetra-iso-amly-ammonium-bromide)	32.8	- 0.10
TeBr ₂ (Tellurium dibromide) ...	32.2	- 0.17
(C ₂ H ₅) ₄ NBr (Tetra-ethyl-ammonium-bromide)	32.2	- 0.35
(CH ₃) ₄ NBr (Tetra-methyl-ammonium-bromide)	32.8	- 0.067

IODIDES

Compound	Temperature °C	$\chi_m \times 10^6$
SbI ₃ (Antimony iodide, sublimed) ...	32.2	-0.12
SI ₂ (Sulphur iodide) ...	32.0	-0.16
AsI ₃ (Arsenious iodide) ...	32.0	-0.24
(C ₂ H ₅) ₄ NI (Tetra-ethyl-ammonium iodide) ...	32.2	-0.08

Details will be published elsewhere.

Physical Laboratories,
Aligarh Muslim University,
Aligarh, 16-10-40.

Ghulam Farid.

¹ *A. T. C. Paris* 8, 1937.

² *Ibid.*, 17, 1937.

* A. A. Chowdhry, *Current Science*, 8, 550, 1939; and Aligarh Muslim University M.Sc. Dissertation 1940.

Energy-levels of an Artificially Bounded Linear Oscillator

Sommerfeld and Welker¹, because of its possible astrophysical application, have recently discussed the problem of the ground state of the H-atom, subject to the artificial boundary condition that it is enclosed within a sphere of radius r_0 . The eigen-function has to vanish at $r=r_0$, and the energy W of the ground state is a function of r_0 . The electron is bound to the nucleus ($W<0$) for $r>1.835 a_H$ (a_H is the Bohr-radius, $a_H=0.53 \text{ A.U.}$), while for $r_0>1.835 a_H$, W is positive.

The present note deals with the case of the linear harmonic oscillator.

The Schrödinger equation is

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2m}{h^2} \left(W - \frac{1}{2} \alpha x^2 \right) \psi = 0, \quad (1)$$

where m is the mass of the particle and $\frac{1}{2}ax^2$ its potential energy for a displacement x . It is usual to define a proper-frequency ν_0 by $\nu_0 = \frac{1}{2\pi} \sqrt{a/m}$.

and write equation (1) in the form

$$\frac{d^2\psi}{d\xi^2} + \left(n + \frac{1}{2} - \frac{1}{4}\xi^2\right)\psi = 0 \quad (3)$$

where $W = h\nu$, $(n + \frac{1}{2})$,

$$\text{and } \xi = x \left(\frac{4\pi}{h} \sqrt{am} \right)^{\frac{1}{2}}. \quad (4)$$

The natural boundary condition is $\psi \rightarrow 0$ as $x \rightarrow \pm \infty$, and for this case n is a positive integer including zero.

We shall consider the oscillator subject to the artificial boundary condition that $\psi = 0$ at $x = \pm l$, i.e., the oscillator is enclosed between infinitely high and infinitely steep potential walls at $x = \pm l$. Solving (2) by the method of approximate solution we find that

$$W = \frac{h^2 q^2}{8ml^2} \left[1 + \frac{1}{3\pi^2 q^2} \left(\frac{l}{l_0} \right)^4 \left(1 - \frac{6}{\pi^2 q^2} \right) \right], \quad (5)$$

$$\text{or } W = \frac{\pi^2 q^2 l^2}{4l^2} \left[1 + \frac{1}{3\pi^2 q^2} \left(\frac{l}{l_0} \right)^4 \left(1 - \frac{6}{\pi^2 q^2} \right) \right], \quad (6)$$

which is valid so long as the second term in the brackets [] is small compared to unity. The length l_0 is defined by

$$l_0 = \left(\frac{h}{2\pi^2 \nu_0 m} \right)^{\frac{1}{2}}. \quad (7)$$

l_0 corresponds to the (classical) 'amplitude' of the oscillator when its energy is $h\nu_0$ and q is an integer; it is one for the ground state, two for the second state, and so on. For the natural boundary condition $l \rightarrow \infty$, $W_\infty = h\nu_0 (q - \frac{1}{2})$.

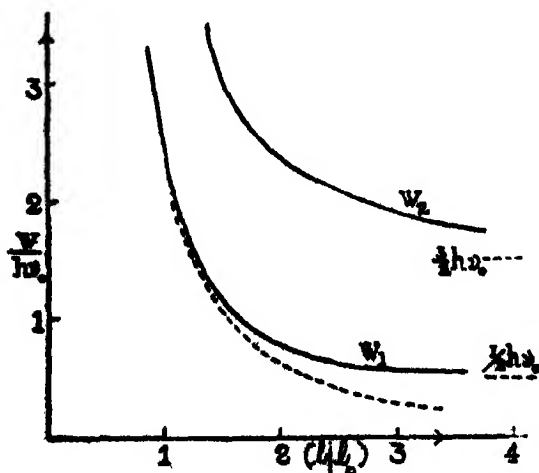


FIG. 1.

The curve W_1 is for the ground state and W_2 for the second state. $l_0 = \left(\frac{h}{2\pi^2 \nu_0 m} \right)^{\frac{1}{2}}$. The dotted curve represents

$$\frac{W}{h\nu_0} = \frac{\pi^2}{4} \left(\frac{l}{l_0} \right)^2 \quad \text{or } W = \frac{h^2}{8ml^2}$$

Figure 1 represents $W/h\nu_0$ against l/l_0 for the ground state ($q=1$) and the second state ($q=2$). The dotted curve corresponds to

$$W = \frac{h^2}{8ml^2} \quad \text{i.e., } \frac{W}{h\nu_0} = \frac{\pi^2}{4} \left(\frac{l}{l_0} \right)^2.$$

In the case of the ground state, when $l > 3l_0$, the oscillator behaves as a practically unbounded oscillator and the energy is very nearly $\frac{1}{2}h\nu_0$. As l decreases, the energy increases and for $l < \frac{1}{2}l_0$ the energy is practically given by $\frac{h^2}{8ml^2}$.

To illustrate an application of these results we take a recent investigation by Wildhack² on the proton-deuteron transformation as a source of energy in dense stars. He considers the motion of a proton in the interior of a white dwarf to correspond to an oscillator of proper frequency ν_0 .

$$\nu_0 = \left(\frac{2.3}{8\pi^2} \frac{e^2}{m_H r^3} \right)^{\frac{1}{2}}. \quad (8)$$

where e is the electron charge, m_H the proton-mass and $2r$ is the distance between nearest protons. r will correspond to l in our theory. The energy in the ground state is taken by Wildhack to be $\frac{1}{2}h\nu_0$. This, however, as we have seen, is justified only so long as $l > 3l_0$, which on substituting from (7) and (8)

$$\text{gives } r > \frac{81}{2.3} \frac{m_0}{m_H} \quad a_H \sim 1.0 \times 10^{-10} \text{ cm.},$$

where m_0 is the mass of the electron. For smaller values of r , the energy will be appreciably greater than $\frac{1}{2}h\nu_0$. However, to neglect this increase in energy with r decreasing below 10^{-10} cm. is not inconsistent with Wildhack's investigation as it is concerned with the lower limit of the rate of energy evolution in stellar matter.

A detailed discussion of the problem of the bounded simple harmonic oscillator will be published elsewhere.

Department of Physics,
University of Delhi,
Delhi, 18-10-1940.

D. S. Kothari.
F. C. Auluck.

¹ Sommerfeld and Welker, *Ann. d. Physik*, 32, 56, 1938.

² Wildhack, *Phys. Rev.*, 57, 81, 1940.

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No. 7

The Drugs and Pharmacy Acts for India

THE passing of the Drugs Act by the Central Legislature in April last and the shortage of drugs due to the stoppage of imports from the continent of Europe have brought to the fore the question of developing the pharmaceutical industry in this country. The cognate subject of a proper reorganisation of pharmaceutical studies in Indian universities is also receiving attention. The Government of India has assured the Legislature that a comprehensive Pharmacy Bill will be taken up in the near future and has expressed the hope that the twin measures will so regulate the import, manufacture and sale of drugs and so organise the profession of pharmacy that the Indian public will have a very efficient service in a matter of such vital concern to the nation.

The Drugs Act, in spite of some defects and shortcomings which we hope will soon be remedied, is a well-conceived measure and as such has been welcomed everywhere. The control of drugs has been always found to be a problem of considerable difficulty and complexity. Even in countries imbued with the spirit of modern science, there is a great demand for secret remedies. In India where right thinking in such matters does not practically exist and where the public are exceedingly credulous and believe in all kinds of mysticism, the task before the physician and the pharmacist is almost superhuman. In India many of the most serious diseases are amenable to proper treatment by drugs whose value has been assessed by proper scientific methods, e.g., malaria, kala-azar, diphtheria, amoebic and bacillary

dysentery, relapsing fever, syphilis, etc. The administration of useless remedies in these cases is not a harmless comedy. It is a question of life and death. Victims of quacks are no less to be pitied than victims of Nazism or imperialistic capitalism and we cannot in this country adopt too soon a therapy based on the principles of exact science. We are glad that the Drugs Act prohibits the sale of patent medicines unless there is displayed on the label the true formula or a list of ingredients contained in them. As a further step in this direction, "the insertion of advertisements of remedies for which exaggerated unwarranted and fraudulent claims are made should be prohibited". This will prevent to a large extent the cruel fraud which is being perpetrated on ignorant and helpless people by supplying them with bogus remedies.

But such types of regulating and prohibiting measures will not suffice. We should not forget for a moment that ours is almost the poorest country in the world. The aim should be to bring the blessings of modern therapy to the door of the poorest. Simultaneous progress in many directions is necessary to achieve this end, and well-planned State efforts appear essential for success.

The change from the administration of wild herbs in the crude state to that of synthetic drugs or potent biological preparations is perhaps one of the highest achievements of human endeavour. But unfortunately these drugs and biological preparations are manufactured under such an economic system that their benefits are only enjoyed by a few. We

are told that in Russia patent laws do not apply. The Soviet Government make all the medicines that are needed for the people of the republic with the most cynical disregard of the rights of those foreign capitalistic concerns who claim proprietary control over the production of such drugs. The result is, that highly specific modern drugs can be supplied to the masses of the Soviet Republic at a cost which is very small compared with the prices that prevail in countries which observe the patent laws. In fact, that Government takes pleasure in disclosing to all health organisations in all parts of the world, details regarding the processes for the manufacture of important drugs in Russia. Thus, the method that is employed for the manufacture of atabrin in Russia, has been given in detail to an important public health organisation in India. The great Pasteur, who is the father of modern preventive medicine and the therapy based on biological preparations, never took any patent to enjoy the fruits of his discoveries. Why should not his example be followed by discoverers that come after him? But until that consummation comes, the Government of India will do well to enact that patent rights, held by nationals or concerns of enemy countries or their branches in neutral countries, can be disregarded in India and that drugs like prontosil, atabrin, salvarsan, etc., can be manufactured and sold freely in India subject to the general control of the Drugs Act. We draw the attention of Dr J. N. Ray, who has just been appointed to the newly created post of director of drug production to this aspect of the problem; and we hope that after the war is over, the main problem before the director should be to so lower the cost of drugs that they may be available to the remotest village.

The Indian Drugs Enquiry Committee recommended very strongly that steps should be taken immediately to bring into being an Indian pharmacopoeia. The majority of drugs included in the pharmacopoeia of any country are derived from the vegetable kingdom. Sir J. D. Hooker once observed that the flora of British India was more varied than that of any other country of equal area in the globe. The researches of Col. Chopra and his school point to the possibility of manufacturing from Indian vegetable products any drugs almost equal in therapeutic value to those that are often imported now. The minor forest products sections of the forest departments in India are now keenly alive to the cultivation and systematic collection of herbs of pharmacological value. Such efforts can be given

an impetus, and organised on a permanent basis, if the preparation of an Indian pharmacopoeia is immediately taken in hand. In the debate on the Drugs Bill many non-official members of the Assembly pressed this point of view strongly. No assurance was however forthcoming from the Government that this demand will be considered sympathetically. Pharmaceutical studies of Indian drugs are still in their infancy. The difference in chemical composition and physiological action of varieties of the same species, the stage of growth at which maximum therapeutical potency is attained, the nature of adulterants commonly found—these and many other matters of similar kind require thorough investigation. And, this can only be effectively done by a State agency provided with ample resources and charged with the duty of preparing an Indian pharmacopoeia. The expenditure involved in the venture will amply repay itself by lowering the cost of drugs of indigenous origin and bringing them within the purchasing power of the bulk of our countrymen.

Administration of modern medicaments requires skilled physicians who have been properly trained in modern hospitals in up-to-date methods of diagnosis and scientific therapy. There is a school of thought who believe that for rural areas, the orthodox indigenous systems of Ayurvedic and Unani medicines are sufficient. This is a pernicious view. The art of healing should make no distinction between the rich and the poor. We hope that soon enough all that is best in the indigenous systems will form an integral part of the Indian national pharmacopoeia. The aim should be to train up only one type of medical practitioners in the country—and that, the best. The services of such medical men should be made available to the people in the economically backward rural areas, by a system of State subsidy which will encourage them to settle down in the country. Indeed this policy has been followed for some time by the Madras Government; and, it appears, with considerable success.

In any scheme for the regeneration of the pharmaceutical industry of the country, the pharmacist must hold the key position. There is a good deal of confused thinking prevalent in India regarding the status and scope of activities of a pharmacist. Modern pharmacy includes the following main subjects of study:

(a) Crude drugs, their botanical sources, their identification, and the detection of their substitutes

and adulterants—this branch is known as pharmacognosy.

(b) Standardisation of pharmaceutical substances, and their preparation by chemical methods wherever possible—this branch is known as pharmaceutical chemistry.

(c) Preparation of materials in a *convenient form* for use as medicines and preparation of medicines from chemical or biological sources in forms suitable for administration or application—this branch is known as pharmaceutics.

The medical organisation of this country has so far regarded the medical men both as physicians and pharmacists and did not recognise any independent profession of pharmacy. This was perhaps natural in the early stages of application of modern medical science in India. But the experience of advanced countries has shown the advantage of separating the two professions, and the time for making such a change in India is ripe. The manufacture and dispensing of drugs have now become a specialist's job and the sooner it is so recognised the better. Until recently there was no provision in any of the universities for the teaching of pharmacy. The Hindu University of Benares with commendable foresight included in 1932, pharmaceutical chemistry as one of the subjects for the degree of bachelor of science. This was followed up in 1937 by a comprehensive three years' course leading to the degree of bachelor of pharmacy. Some time ago the Government of Bengal appointed a committee with Col. Chopra as chairman to draw a scheme for a college of pharmacy, and Dr Ankelsaria of Ahmedabad promised a donation of two lakhs of rupees for the establishment of the college. It is not known how far the scheme has progressed, but the University of Calcutta has very lately introduced pharmaceutical chemistry as a special subject in postgraduate studies. In Madras, the universities have been more alive to the needs of higher pharmaceutical studies, and the subject now forms a part of the B.Sc. degree course in both Andhra and Madras Universities. These are pointers in the right direction. The administration of the Drugs Act and the proposed Pharmacy Act will create a continuous demand for pharmacists who will not only be dispensing medicines, but also will be highly trained experts who will be in the main responsible for manufacture of pharmaceutical preparations and for the inspection and testing of drugs imported or manufactured in India. It is very desirable therefore

that the Central Government should supplement the efforts of provincial Governments and universities for improving the facilities of pharmaceutical training by liberal grants. The Drug Committee recommended that funds might be raised for this purpose by the imposition of an extra 5 per cent. import duty on drugs and by the suitable levy of excise duty on proprietary medicines manufactured in India. Whenever, in India, there has been a public demand for the large scale development of industries the counter suggestion has been made that such development is not possible for lack of experts. And again facilities for training experts in India have been objected to on the ground that there is little likelihood of the absorption of such experts in industries. A determined attempt must now be made to break this vicious circle which vested interests would like to keep going on its merry round for an indefinite future; and the custodians of public funds should be presented with the united demand of the people that the purse strings shall always be open for training in our own country the technicians that we require for our industrial development. The development of the pharmaceutical industry is a part of this bigger problem, and, in view of its intimate relationship with the health of the nation, should receive the immediate attention of the public and the Government.

While advocating the recognition of pharmacy as an independent profession, we should stress all the more the need of the closest co-operation between research workers in the field of medicine and synthetic chemistry in India. Indeed the members of the chemical and the medical professions have a heavy responsibility to discharge at this juncture. The rapid advance in modern therapeutics in Europe and America has been due to their intimate and continuous co-operation. "Progress in the field of evolution of new medicaments cannot be achieved by medical men and chemists working single-handed in water-tight compartments isolated from each other and following up their own leads. They must guide and be guided by each other in their effort to seek the truth There are, at a moderate estimate, nearly 10,000 synthetic compounds awaiting to be pharmacologically and clinically evaluated without which they will remain only as academic curiosities and never find use in therapeutics In our country Sir U. N. Brahmachari gained signal success in the elaboration of a new compound for treatment of kala-azar because he combined in himself both chemical and medical knowledge. Therefore the

highest hopes for further results in productive drug synthesis can lie only where chemists and biologists work together, endeavouring to promote knowledge which will be of value in the relief of human suffering. Lucky indeed is the pharmacological research worker who can secure the sincere services of a synthetic chemist, and conversely, lucky is the synthetic chemist who has a pharmacologist as a collaborator."* It is a welcome sign of the times that the Indian Institute of Science at Bangalore has

taken a forward step in creating a lectureship in pharmacology to carry on collaboration work with the department of chemistry. We hope that this example will also be followed in all the higher centres of research in chemistry in India, and the talents of Indian chemists will be harnessed in association with those of pharmacologists to produce newer and more potent drugs for the alleviation of human suffering.

* Extracts from an address by Dr B. Mukerji to the Institution of Chemists (India).

HUMAN ACTIVITY AND CLIMATIC CHANGES

Dr Clarence A Mills, professor of experimental medicine at the University of Cincinnati writes in the *Scientific American* of October, 1940 that years of investigation have revealed that the primary basis of variations in human capacity for doing things is the ease or difficulty of heat loss from the body. This capacity however differs widely from place to place and from time to time. Every activity of body is dependent on the combustion of foodstuffs in the the cells and the consequent liberation of heat and energy. Hence the factors that determine the combustion rate control the general activity and the energy level of the individual. On the basis of Weather Bureau statistics for the past 65 years, Dr Mills has correlated the temperature changes of the climate with business activity and has found remarkably high coincidence of business recessions with the periods of elevated temperatures and vice versa. He has investigated the body growth of mice in relation to environmental temperature and has shown that the mouse raised under identical conditions except in a cold atmosphere has a large and robust form. But the ones raised in warmth live longer, though less actively. Recently air-conditioning of offices and factories has been found to give extra energy and efficiency to the workers.

The gradual rise in earth temperature follows a cyclic curve comprising nearly 2000 years. The last high point came with the warmth of the Middle Ages (800-1000 A.D.) the low point occurring about 1850. Since then the temperature has risen, and specially after 1920 the rise is very severe. Dr Mills observes that it was the cold of the last century which provided an abundance of energy and inventive genius. The present decay of the population including fall in birth rate has been attributed by him to the rise of temperature.

Harappa

RAMAPRASAD CHANDA

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SEALS with the figure of one-horned Urus bull and picture-writing that are the most characteristic relics of the Chalcolithic civilisation of the Indus valley were first discovered on the mounds of Harappa on a dry bed of the Ravi in the Montgomery district in the Punjab. Sir John Marshall arranged the excavation of Harappa in 1920-21 through late Rai Bahadur Dayaram Sahni. Late Mr. Rakhaladas Banerji initiated the excavations at Mohenjo-daro a year later. Since then, the excavations of both the sites have been continued for a decade simultaneously. But though the site of Harappa was discovered first, and its excavation was first begun, adequate publication of the discoveries made there has come last. The excavations at Mohenjo-daro between 1922 and 1927 have been described and illustrated in three magnificent volumes entitled *Mohenjo-daro and the Indus Civilisation* edited by Sir John Marshall (1931), and those between the years 1927 and 1931 in two volumes entitled, *Further Excavations at Mohenjo-daro** by Dr E. J. H. Mackay (1938). Excavations at Harappa were carried on by late Rai Bahadur Dayaram Sahni between 1920 and 1925, and by Mr Madho Sarup Vats continually for eight years between 1926 and 1934. The results of these operations have now been published by Mr Vats in two volumes.†

Mr Vats has carried out his work carefully and conscientiously, and his volumes are worthy complement to the five volumes on the excavations at Mohenjo-daro. Sir John Marshall considers the remains of Mohenjo-daro "probably not earlier than 3250 B.C., or later than 2750 B.C.", and thus attributes to the city a lifetime of 500 years. Dr Mackay, on the basis of finds at Tell-Asmar in Mesopotamia,

puts the upper limit to about 2500 B.C. and allows 300 years between the uppermost and the lowest attainable strata of Mohenjo-daro. Mr Vats adopts Sir John Marshall's scheme of chronology of the ruins of Mohenjo-daro for fixing the approximate date of the strata of the remains of Harappa, but he proposes to push backward the age of the city by 250 years (3500 B. C.). His evidence for such a conclusion is thus stated by him :

"Stamped seals of the types described above diminish both in size and numbers from the IVth stratum downwards in Mound F ; and so also do the terracotta and faience sealings. Their place is taken by a class of very small seals and sealings which are not represented at all at Mohenjo-daro, presumably because the strata exposed on that site are posterior to the age to which these early seals belong. A few of the larger seals have, it is true, found their way into the earlier strata and a few of the miniature seals into the later, but such occasional finds can hardly cause surprise, when we bear in mind the extent to which this site has been dug into and despoiled in the past ; nor do they invalidate the conclusion that the larger seals were preceded by the miniature ones" (page 324).

The small seals and sealings may be local products not used by the population of Mohenjo-daro, and therefore their absence from the lowest stratum of Mohenjo-daro does not necessarily indicate the posteriority of that stratum to the miniature seal-bearing strata of Harappa. Deep digging carried on by Mr Vats of Mound F at Harappa has not enabled him to trace the crude beginnings of the culture of the city. The best-executed representation of a Brahmani bull occurs on a square steatite seal found in association with stratum VII (page 97 ; Pl. XCI, 236). The figure of a crocodile carved on the reverse of a tiny seal found in the same stratum is not ill-executed (Pl. KCVI, 430). In the VIIIth stratum three terracotta objects were found which Mr Vats

* A detailed review of these volumes was published in *SCIENCE AND CULTURE*, 5, 5-9, 89-94, 1939-40.

† *Excavations at Harappa* : Being an account of archaeological excavations at Harappa carried out between the years 1926-21 and 1933-34. By Madho Sarup Vats, M.A., Deputy Director-General of Archaeology in India, Delhi, 1940. In two volumes. Price Rs. 42/-.

does not think it worth while to reproduce. He observes, "It is possible that below VIIIth stratum virgin soil has already been reached" (page 97). So it may be inferred that the city of Harappa was founded after the people of the Indus valley had already developed their civilization, their peculiar picture-writing and seal-making.

Of far greater interest than the earlier strata of Harappa is the prehistoric cemetery in area H which is later in date than the latest stratum of the remains of the city proper. Nature helped Mr Vats to discover the precious relics buried in this area. Rain water rushing over the site after a heavy shower uncovered the neck of one of a group of four burial pots which lay concealed almost immediately below the surface. Only three feet to the south, Mr Vats discovered seven other burial pots and was thereby convinced that he had discovered a cemetery, and then made necessary arrangement for the excavation of the area on a reasonably extensive scale. In this cemetery Mr Vats distinguishes two strata. In the upper stratum selected bones of the dead are put in jars and buried; in the lower stratum either the entire body or a part of it is laid on the earth and buried. The type of burial of the upper stratum Mr Vats designates pot-burial, and of the lower stratum, earth-burial. On archaeological evidence Mr Vats considers the two strata of burials more or less contemporary. He writes:

"Now, as sherds typical of burial pottery of Strata I and II were, in many cases, found mixed up together on the mounds, it is unlikely that the two strata were separated from each other by any very great length of time, and the fact that in the Cemetery itself there is not much debris between them lends further support to this view. Further, in so far as earth-burials must be inhumed at a safely low level, the mere fact that pot-burials lay above them or at a higher level would not necessarily indicate an earlier date for the former; indeed it is quite conceivable that the two strata which are not separated by any structural remains, may be more or less contemporary" (Page 234).

But on account of what Mr Vats regards as the radical difference of methods of disposal of the dead between jar-burial of stratum I on the one hand, and earth-burial, complete or fractional, of stratum II on the other, he holds "that this sudden and startling change from one kind of burial to the other within a comparatively short space of time was due to some

racial or cultural upheaval brought about by the immigration of a foreign people into this district of the Punjab". Though laying stress on racial or cultural upheaval as the probable cause of the change from the earth-burial to the jar-burial, Mr Vats does not consider the evolution of the latter type from the former an impossibility. He divides the cemetery into an western section and an eastern section. In the eastern section fractional burial or burial on earth of a few selected bones of the dead is rare, but in the extension of the western section the earth-burial is invariably fractional (page 220). The change from the complete earth-burial to the fractional earth-burial presupposes the exposure of the dead body to be torn to pieces by carnivorous animals and birds, and, after its partial destruction or loss, burial of the remnants. The ideological difference between the preservation of the whole body by burying it, and exposing the body till only a few bones remain to be buried, appears to be much wider than the burial of a few selected bones on the earth or burying them in a jar.

Mr Hargreaves excavated Sohr Damb near Nal in the Jhalawan District in Baluchistan and therein found three types of inhumation: (i) complete burials in defined graves (within walls of sun-dried bricks); (ii) complete burials in undefined graves; and (iii) fractional burials where a few selected bones are placed on earth or deposited in jars. Of the latter class of fractional burial Mr Hargreaves gives two indisputable examples:

(Group E in A 6)—"A large broken, open bowl contained earth and five smaller vessels. *In the earth and between the small vases* were pieces of a rib, part of a pelvic bone and many small bones. These appear to have been placed therein".

(Remains in Trench E)—"A shallow bowl found in A13 held a small damaged squat pot and between the two was the curved fragment of a skull which could not possibly have found its way there by accident, Pl.XVC."*

Like area H at Harappa, Mr Hargreaves found Sohr Damb "to be devoted entirely to the purposes of a necropolis" (cemetery). About the relative age of the burials Mr Hargreaves writes, "One thing is certain, that at Nal (Sohr Damb) several different forms of inhumation were in vogue at the same time and these cannot represent any evolutionary process".† On the analogy of the burials at Sohr Damb, Mr Vats' suggestion that earth-burials must be at a

* Mem. A. S. I., No. 35, page 24-25.

† Mem. A. S. I., No. 35, page 28.

safely low level, the mere fact that pot-burials are found at a higher level does not necessarily indicate a later date for the former, is a sound one.

Though the change from earth-burial, complete or fractional, to fractional jar-burial may not be considered a cultural upheaval, the change from cremation to burial does indicate such an upheaval. Sir John Marshall has fully dealt with the different methods of disposal of the dead at Mohenjo-daro and Harappa in the *Mohenjo-daro and the Indus Civilisation*, Chapter VI. He concludes, "To revert, however, to Mohenjo-daro and Harappa—so far as our evidence goes at present it seems probable that the usual method of disposing of the dead during the flourishing period of the Indus Civilisation was by cremation. That cremation was practised is conclusively proved, as we have been, by the finding of cinerary urns or other receptacles containing calcined human bones and ashes together with vessels of burnt and other offerings for the dead and the sundry articles for use in after life". Dr Mackay writes in the *Further Excavations at Mohenjo-daro*, "The complete absence of burials, save a few which circumstances suggest were the victims of tragedies and a few fractional burials, points to cremation as the chief mode of disposal of the dead" (page 648). According to Sir John Marshall, "the few examples of fractional burial that appear at Mohenjo-daro and Harappa during the Indus Period are due to the presence of foreign elements."

Whence came these foreign elements who practised the burial of selected bones in jars found in the ruins of the cities of Mohenjo-daro and Harappa, and whence came the people whose dead are buried in the cemetery in Area H at Harappa? As the culture of this people is akin to the culture of the people who buried their dead at Sohr Damb (Nal) and Shahi-tump in Baluchistan and may be traced as far as Persia, Sir John Marshall suggests that they came from the west. The last and the largest batch of these immigrants came when the old city of Harappa was in a state of decline and occupied it. These immigrants consisted of two elements, one of which practised complete burials of the dead, and the other practised first exposure of the dead and then fractional burial. Fractional burial, whether on earth or in jar, is a combination of the two usages, inhumation and exposure.

Do these latest settlers of Harappa bring us nearer to the Vedic Aryans than their predecessors in point of culture? Mr Vats leaves this question open.

"The connexions or affinities between the Vedic Aryans", he writes, "and the cultures connected with the Harappa burials are not yet quite clear" (p. 209). But he notes certain similarities in beliefs on the basis of paintings on the burial jars. He endeavours to explain these paintings in the light of Hindu beliefs in life after death as defined in the Hindu sacred books. But it seems to me safer to trace the inspiration of these paintings on the burial jars of the Harappa cemetery on the one hand, and those on the funeral pottery of Sohr Damb (Nal) and other similar sites of Baluchistan on the other, to a common source.

Different modes of disposal of the dead practised by the Vedic Aryans has been fully discussed by me in a paper entitled *The Indus Valley in the Vedic Period** from which I shall give an extract:—

"The way or ways in which the Vedic Aryans disposed of their dead is first referred to in the funeral hymns of the *Rigveda* (10, 15-18), most of the stanzas of which also recur in the *Atharvaveda*, Book 18, and the *Taittiriya Aranyaka*, Chapter 6. In one stanza of the *Rigveda* (10, 15, 14) fathers who are *agnidagdha*, 'cremated', and who are *anagnidagdha*, 'not cremated', are referred to. This stanza also occurs in the *Atharvaveda* (18, 2, 34) and, with slight variation, in the *Vajasaneya Samhita* or the White Yajurveda (19, 60). 'Not cremated' or 'not burnt with fire' does not necessarily mean 'buried', as Prof. Macdonell supposes, but may as well refer to those who could not be cremated by accident. *Rigveda* (10, 18, 10-13) is supposed by some to refer to the burial of the uncremated body. But according to the *Asvalayana-grihya-sutra* (4, 5, 7-10), these stanzas refer, not to the burial of the uncremated body, but to the burial in a cinerary urn of the bone relics of a body that has already been cremated".

The author of the *Sutra* presupposes the preservation of considerable number of bones after cremation for burial in an urn. It is stated (4, 6, 5-6), "With the thumb and the fourth finger they should put each single bone (into the urn) without making a noise. The feet first and the head last". The students of the different Vedas, the *Rigveda*, the *Samaveda*, the *Atharvaveda* and the *Yajurveda* in its two recensions, the Black Yajurveda and the White Yajurveda, practically formed six different sects of Brahmins who evidently followed different methods

* *Mem. A. S. I.*, No. 31, Calcutta, 1926. For references and extracts on the disposal of the dead see pages 9-13.

of post-cremation burial of calcined bones. According to the *Kausikasutra* of the *Atharvaveda*, the calcined bones are collected on the third day after cremation and deposited in a jar which is buried under a tree. But later on the bones are taken out of the jar and deposited on earth in a pit where they are rearranged in the form of a human skeleton. According to the ritual book, the *Satapatha Brahmana* of the White Yajurveda, the charred bones are poured from the jar on ploughed land, rearranged in the form of the skeleton of the dead man limb by limb; thirteen bricks, each measuring a foot square, are then placed on them, and a mound of earth is erected on the bricks. This was the custom of the westerners or inhabitants of the Indus valley according to this authority. The easterners and others first covered the entire site with bricks and then placed the bones and erected the mound on them. According to the *Pitrmedhasutra* of Gautama attached to the *Sama-veda*, the burial of the jar containing charred bones at the root of a tree is the final act of disposal of the dead. In the *Pitrmedhasutra* of Hiranyakesin attached to the Black Yajurveda, burial in jar is provided for one who has not established the sacred fire or for a woman, depositing on the earth for one who has performed the Haviryajna (offering of rice cakes and butter), re-cremation for one who has performed the Soma sacrifice, and the collection of bone relics for the builder of the fire altar. These diverse methods of disposal of the calcined bones could not all have originated among the Vedic Aryans whose poets composed the hymns of the *Rigveda*, and the permanent jar burial was probably a survival from the pre-Aryan chalcolithic culture of the Indus valley. No burial jar assignable to the Vedic folk and the Vedic age has been discovered. The only remains of the class so far known are the relic caskets of the Buddhist stupas enshrining calcined bones of Gautama Buddha and his chief disciples. The people who lie buried in the cemetery at Harappa, Area H, were a body of strangers who failed to make any lasting contribution to the cultural history of the Indus valley.

Among other unique finds from the ruins of Harappa the most notable are the fragments of two stone statuettes. One of these is a small torso (height $3\frac{3}{4}$ inch) of a nude male figure carved in the round in red sandstone (Fig. 1). Mr Vats discovered it in stratum III of Mound F. The chief characteristic of this torso is the strong tendency to anatomical accuracy on the part of the artist. The statuette partially resembles a specimen of Greek art.

But the findspot renders the assumption of such late date untenable. Mr Vats writes, "Let me state at the outset that, although a large area—larger than anywhere else at Harappa—has been explored on this mound, not a single object which is not referable to the pre-historic period has ever been found in it. The findspot alone of this figure would, therefore, leave little room for doubt as to its pre-historic age" (page 75). He adds in a note, "At Harappa there is only one little spot, and that, too the highest part of the highest mound AB where Gupta things have been found. Elsewhere everything belongs to the Indus period." After a careful analysis of the evidence of materials, technique, and style, Sir John Marshall has drawn the inevitable conclusion that this torso cannot be a work of the Indo-Hellenistic or any other latter-day school.*

The other statuette (Fig. 2) is the fragment of a dancing figure of dark grey stone (height 3.9 inch). It was discovered by late Rai Bahadur Dayaram Sahni in the IVth stratum (Intermediate I level) in another part of the same mound at a spot where none but pre-historic remains have come to light. Sir John Marshall thus describes this curious figure:

"Although its contours are soft and effeminate, the figure is that of a male, and it seems likely that it was ithyphallic, since the *membrum virile* was made in a separate piece. I infer, too, from the abnormal thickness of the neck, that the dancer was three-headed or at any rate three-faced, and I conjecture that he may represent the youthful Siva Natesa. On the other hand, it is possible that the head was that of an animal. Whatever it may have been, no parallel to this statuette is to be found among Indian sculptures of the historic period."

As noted by the same authority, pose of this figure is that of a dancer and "is full of movement and swing". In it the artist aims not so much anatomical truth, but expression of the rhythmic movement of a dancer.

A statuette of this type carries us near the peak of artistic development. Are we justified in attributing to the Indus people such high degree of progress in plastic art? The same height of artistic development is approached from another (non-realistic) direction by a statue of steatite found 4 ft. 6 in. below the surface of the ground at Mohenjo-daro, DK area. The arms and the lower portion of this

* *Mohenjo-daro and the Indus Civilisation*, page 45-46.



FIG. 1

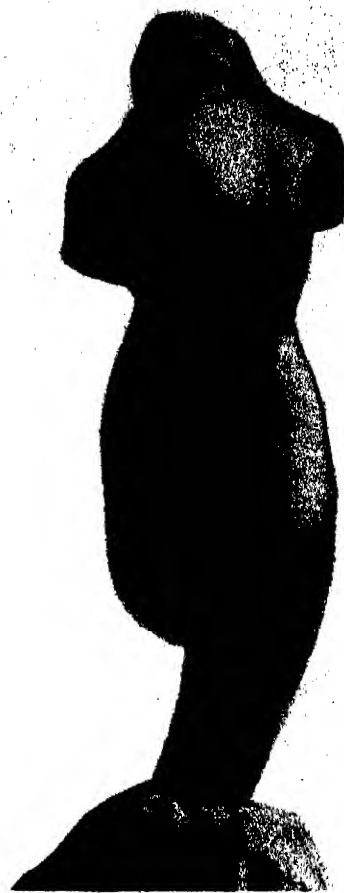


FIG. 2



FIG. 3



FIG. 4



FIG. 5

statue are missing. The fragment is 7 inches high. Dr Mackay thus describes it—

"This is by far the finest piece of statuary that has been found at Mohenjo-daro. It looks like an attempt at portraiture, and represents the head and shoulder of a male figure. The figure is draped in an elaborate shawl with corded or rolled overedge, worn over the left shoulder and under the right arm The figure wears a short beard and whiskers and a closely cut moustache. The eyes are long and half closed, but they are set straight and are not at all Mongoloid in type."*

A glance at the face of this statue shows that the eyes are half closed and fixed on the tip of the nose with a definite purpose, like the eyes of one engaged in performing *yoga*, and reveals a mind engaged in meditation. The expressiveness of this statue marks it as a genuine work of art. As pointed out to Sir John Marshall by experienced sculptors, an artist who could engrave the seal with the very accurate figure of the bull reproduced by him on the cover of his volumes would have had little difficulty in carving the statuette of red sand stone (torso)† To this remark I should add, an artist who could give expression to the restrained movement of the eye-lids and the mental repose of the statue of steatite from Mohenjo-daro would have had little difficulty in carving the statuette of the dancer of dark grey stone.

Other notable antiquities unearthed at Harappa are, seals bearing images of deities in *yoga* postures (Pl. XCIII). The *asana* or posture of *yoga* is first defined in the *Svetasvatara Upanishad* (2—8), "Holding his body steady with the three (upper parts) erect." One other trait of the posture is added in the *Bhagavadgita* (6,13) where it is thus described: "Holding his body, neck and head erect, unmoved and steady, gazing at the tip of his nose, and not looking around." So the most essential features of the posture of *yoga* are, holding the spinal column erect and partially closing the eyes in such a manner as to prevent it from looking around. Other features of the posture of *yoga* vary, distinguishing different postures described in the manuals on the subject. The commonest posture of sitting for the performance of *yoga* is the *paryankabandha*, cross-legged, or *padmasana*, lotus posture. This posture requires the *yogi*, in addition to holding the three upper parts of the body erect, and fixing the eyes on the tip of the nose, sitting cross-legged and placing

the hands one upon the other on the lap. The seated images of the Jinas or Tirthankaras of the Jains are invariably in this posture. Most of the seated images of Brahma, Vishnu, Siva and the Buddha are in this posture, but with different arrangement of the arms. On Harappa seal 303 (Pl. XCIII) a figure is seated erect on a stool. The legs do not cross each other, but the heels touch each other. The arms are stretched and touch the knees. This pose of the arms is invariably assumed by the Hindus who perform meditation nowadays. On this seat there appears to be another figure seated in this identical posture to the right side of the first figure. On either side of this pair are two lions or tigers looking backward. A few more seals bearing figures of deities seated in this postures have been discovered at Mohenjo-daro. The best known example is the figure identified by Sir John Marshall as the proto-type of Siva. The feet of this figure cross each other (Fig. 3). Dr Mackay has reproduced two other seals bearing figures seated in the same posture with their heels touching each other (Figs. 4 and 5). A detailed examination of these figures cannot be undertaken here. Trident on their head shows that they represent deities. Some of the Harappa seals (Pl. XCIII, 307, 317, 318) show figures of a deity standing erect with arms hanging on sides resembling the standing posture of *yoga* of images of the Jinas or Tirthankaras known as the *kayotsarga*, dedication of the body.

Figures of deities in the postures of *yoga* indicate that the postures were otherwise well known, and *yoga* evidently was practised by the worshippers of these deities, for men make their gods in their own image. *Yoga* is practised for gaining two different objects, magical or miraculous powers, and supreme knowledge that leads to salvation after death. Among the Indian religions that advocate supreme knowledge as the path of reaching the supreme knowledge—though differing among themselves as regards the doctrinal content of that knowledge—the most prominent are Upanishadism or Vedantism, Jainism and Buddhism. Do we discern the beginnings of these religions in the Indus Valley in the Chalcolithic age? Impenetrable darkness intervenes between the seals of Mohenjo-daro and Harappa on the one hand, and the earliest Upanishads and the Buddhist and Jain texts on the other. But till archaeology comes to our rescue, it may be possible, by discarding the current dogmas, to endeavour to lift this darkness partially by working backward from the evidence furnished by these texts.

* Mohenjo-daro and the Indus Civilization, Vol. I, pp. 300-307; Pl. XCVIII, 1-4.

† Mohenjo-daro and the Indus Civilization, page 47.

Scientific Research and the Future of Indian Industry

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IN choosing "Scientific Research and the Future of Indian Industry" as the subject of my address* I have been guided by the life story of Sir J. C. Bose himself. The urge which made him devote his whole life to scientific research was created in him by his great desire to see India flourish and prosper like any European country and possibly more because of the bounties with which nature has specially endowed her. He expressed these ideas strongly to me when he came to Lahore in 1927 as president of the Indian Science Congress when I was the local secretary.

He sincerely believed that the present position of Europe and America was based on the fact that they have been the first in the development of the new inventions and discoveries by which the very mode of living of the people has been changed completely. These inventions may be roughly classified in four categories:

1. Those for producing cheap and unlimited power for driving machines and for the transport of persons and goods.

2. Machines doing the most arduous operations of industry, such as would facilitate the making of cloth, cutting and shaping parts of metals and wood at a much greater rate and often of a much greater size than is possible by hand work or by using the early simple appliances.

3. The development of chemical operations on a large scale, such as making of iron and steel and other metals, producing acids, alkalis, salts and other chemicals from coal gas and its bye-products.

* Being the text of the third Sir J. C. Bose Memorial lecture delivered by Dr Bhatnagar on November 30th, 1940 at the Bose Research Institute, Calcutta. The first part of the lecture recalling Dr Bhatnagar's association with the late Sir J. C. Bose has been published elsewhere in this issue. Published with the kind permission of the Director of the Institute.

4. Harnessing for our use naturally occurring products such as petroleum, resins, salts, coal, water, fuel, vegetable oil seeds etc.

It will be a commonplace for me to enumerate here many examples of what scientific research has done to industry in the world. The progress of industry has become so synonymous with science that the modern age has been rightly called the age of science. But as these examples are catalytic in their action, I venture to give some illustrations from the more recent advances in various industries. I am purposely giving some topical illustrations in order to convince the hasty capitalist who wishes to apply science to industry immediately that a certain amount of fundamental research is essential before a discovery or invention can be exploited to its best advantage.

DISCOVERY OF TETRAETHYL LEAD

1. The Perkin Medal of the Society of Chemical Industry for 1937 was presented to Thomas Midgley for his research work which culminated in the discovery of tetraethyl lead and freon. Today 70% of the world's petrol contains tetraethyl lead. Because of the widespread use of this chemical the automotive engineers have been able to increase the efficiency of their engines by raising the compression ratios.† In the new cars of 1936 alone, the increased horse-power thus added to American civilisation was greater than fifty times that which will be obtained from the Boulder Dam and no records in speed or performance achieved by aeroplanes or motor boats could have been made but for the discovery of tetraethyl lead. The story of the discovery of this new compound is told in the following words:

† In this connection the article on 'Octane Number and Super-fuel' in *SCIENCE AND CULTURE*, 6, 200-11, 1940-41, may be found interesting.

In the search for a material with which to control knocking in an internal combustion engine, the following determinations were arrived at by the Edisonian method:

1. Elemental iodine, dissolved in motor fuel in very small quantities, greatly enhanced the antiknock characteristics of the fuel (the basic discovery).

2. Oil-soluble iodine compounds had a similar, though modified, effect.

3. Aniline, its homologues, and some other nitrogenous compounds were effective, though their effectiveness varied over a wide range depending upon the hydrocarbon radicals attached to the nitrogen.

4. Bromine, carbon tetrachloride, nitric acid, hydrochloric acid, nitrites and nitro compounds in general increased knocking when added to the fuel and air mixture.

5. Selenium oxychloride was extremely effective as an antiknock material.

6. A large number of compounds of other elements had shown no effect.

With these facts before him, he profitably abandoned the Edisonian method in favour of a correlational procedure based on the periodic table. What had seemed at times a hopeless quest, covering many years and costing a considerable amount of money, rapidly turned into a "fox hunt". Predictions began fulfilling themselves instead of fizzling. Diethyl selenide was prepared and worked as expected; diethyl telluride next fulfilled his predictions and seemingly his wildest dreams of success had been realized.

Then finally following the lead of the Periodic Classification other compounds were discovered which were effective and the choice finally fell on tetraethyl lead which is now a household word with all those interested in aviation or motor traffic.

DISCOVERY OF FREON GAS

The other example which I wish to present concerns the use of the periodic table in connection with the development of the organic fluorides as refrigerants by Midgley and his collaborators. The story is best told in his own words:

"In the case of lead tetraethyl we were tracing a hitherto unknown property through the periodic table to discover in which element it would become maximum. This required much synthetic chemistry and presented many

difficulties in properly evaluating the results, all of which took years to accomplish. The case of the refrigerants was distinctly different. We were looking simply for a compound, or a group of compounds, in which would be combined certain well-known properties. This was accomplished in three days.

"I was in the laboratory one morning and called Kettering in Detroit about something of minor importance. After we had finished this discussion, he said, "Midge, I was talking with Lester Keilholtz last night and we came to the conclusion that the refrigeration industry needs new refrigerant if they ever expect to get anywhere. So I told Lester that I would call you and have you see him to talk it over. He is leaving you for Dayton tonight". L. S. Keilholtz was chief engineer in his office discussing this problem. What was wanted was obvious—a nontoxic nonflammable refrigerant. On leaving Keilholtz I expressed myself as very doubtful that we would be able to find a single substance suited to the task but that there might be some hope of greatly reducing the existing hazards by using mixtures where nonflammable but toxic materials would be mixed with nontoxic, flammable compounds to give a mixture substantially noninflammable and considerably less toxic than the refrigerants then commonly employed.

"In this frame of mind I returned to our laboratory where I found A. L. Henne and Robert MacNary waiting to have lunch with me. We discussed the problem during lunch and I have Henne's word that my scepticism of solving the problem with a single compound intrigued his interest so much that he gave up his free afternoon and he, MacNary and I went to the library and started to work.

The desired combination of properties was a boiling point between 0° and -40°C ., stability, nontoxicity, and nonflammability. International Critical Tables gave us a partial summary of the volatile organic compounds. The now proved mistake that carbon tetrafluoride boiled at -15°C . struck us in the face and started us thinking about fluorine. No one could doubt at that time that it was terribly toxic, probably too toxic to use even with iso-butane. Perhaps we could add some chlorine compound with beneficial results. Henne suggested chlorofluorides as a class to be investigated further. And so the discussion ran. Recognizing that the International Critical Table list was very incomplete, I decided to bring into play the periodic table. Perhaps volatility could be related to it in some way. It takes but a fraction of a second to see that this is true. In the arrangement according to vacant places the elements on the right hand side are the only ones which make compound sufficiently volatile for the purpose in hand. In fact, only a certain number of these need be considered. Volatile compounds of boron, silicon, phosphorus, arsenic, antimony, bismuth, selenium, tellurium, and iodine are all too unstable and toxic to consider. The inert gases are too low in boiling point. Now look over the remaining elements. Every refrigerant used has been made from combinations of these elements. Flammability decreases from left to right. Toxicity (in general) decreases from the heavy elements at the bottom to the lighter elements at the top. These two desiderata focus on fluorine. It was an exciting deduction. Seemingly no one previously

had considered it possible that fluorine might be nontoxic in some of its compounds. This possibility had certainly been disregarded by the refrigeration engineers. If the problem before us were solvable by the use of a single compound, then that compound would certainly contain fluorine. The heats of formation between the halogens and carbon were checked. They increase from iodine to fluorine, thus indicating a high degree of stability for fluorine-carbon compounds. Everything looked right except that old fear of hydrofluoric acid burns. As it turns out, hydrofluoric acid burns are a special case. Actually gaseous hydrofluoric acid is less toxic than hydrochloric acid, but we didn't know it that afternoon. Next came methods of preparation. Carbon tetrafluoride seemed rather hard to make. And then how could dichlorodifluoromethane boil at -20°C . and carbon tetrafluoride at -15°C .? It just didn't make sense. Plotting of boiling points, hunting for data, corrections, side rules, log paper, eraser dirt, pencil shavings, and all the rest of the paraphernalia that takes the place of tea leaves and crystal spheres in the life of the scientific clairvoyant, were brought into play. We decided that carbon tetrafluoride boiled at about -136°C . or else it was a very special kind of substance. (Not long after this, a publication on the subject appeared. Carbon tetrafluoride boils at -128° not -15°C .) Feeling pretty certain at the time that -15°C . was wrong and that it was a sizable research problem to take carbon tetrafluoride, we selected dichloromonofluoromethane as the starting point for experimentation. I called one of the chemical supply houses by telephone and ordered five 1-ounce bottles of antimony trifluoride. I believe this was all there was in the country at the time.

"It normally would remain for me only to mention the resulting problems of production and safety code fights, to tell the present (pleasingly high) percentage of air-conditioning units which use these organic fluoride refrigerants, and then to mention their use in air-conditioning the deep gold mines of the Rand, but there is one more incident of primary importance that must be told.

"The five 1-ounce bottles of antimony trifluoride arrived. One was taken at random, and a few grams of dichloromonofluoromethane were prepared. One guinea pig was placed under a bell jar with it and, much to the surprise of the physician in charge, didn't suddenly gasp and die. In fact it was not even irritated. Our predictions were fulfilled. We then took another bottle and made a few more grams and tried it again. This time the animal did what the physician expected. We repeated again but this time we smelled the material first. The answer was phosgene; a simple caustic wash was all that was needed to make it perfectly safe. Then we examined the two remaining bottles of antimony trifluoride. They were not pure. In fact, they were both badly contaminated with a double salt containing water of crystallization. This makes phosgene in ample quantities as an impurity. Of five bottles marked "antimony trifluoride" one had really contained good material. We had chosen that one by accident for our first trial. Had we chosen any one of the other four, the animal would have died as expected by everyone else in the world except ourselves. I believe we would have given up what would then have seemed "bum hunch".

"And the moral of this last story is simply this: You must be lucky as well as have good associates and assistants to succeed in this world of applied chemistry sufficiently well to receive the Perkin Medal".

THE REFRIGERATION INDUSTRY

Not all the honours of discovery useful to industry go to chemistry. Physics shares good many of them and occasionally with a rapidity and beauty which bewilders the chemist. One example of physics contributing to the creation of a new industry is that of the production of cold. Cold is really a condition of being without heat. If you impart heat to anything you may make it warmer, if you take heat away, you make it colder.

As far back as 1860 experts began to ask themselves the question as to the possible limit to the removal of heat from a body. The answer given was simple. If we were able to get the temperature of a body down to -273°C . there would be no more heat in it. The temperature 273° lower than the temperature at which ice becomes water is what we call absolute zero. But are we able to take away all the heat from a body? In search for an answer to this question, the science of heat developed an altogether new orientation. The attempts at obtaining the lowest degree of cold have been interesting in two ways, first, because they have resulted in many new inventions and secondly, when the temperature obtained was within ten degrees of absolute zero, some very strange phenomena were observed. One of the inventions which is now known to all is the production of solid carbon dioxide. Thilorier, a French man made solid carbon dioxide about a hundred years back. To him the ice-man of today owes his existence. Carbon dioxide is a common gas obtained in the burning of coal and charcoal as well as in the fermentation process in wine and beer manufacture. It can also be made by the action of an acid on calcium carbonate which is a cheap material available in abundance.

When this gas is put under a pressure of approximately thirty one times as great as the normal air pressure it becomes liquid. When the pressure is suddenly released a certain amount of carbon dioxide as gas comes off very quickly, the temperature is lowered considerably and the liquid gets so cold that most of it goes solid. This solid which is snow-white has normally a temperature of -80°C . The man of science has made use of it for

nearly a century in producing very low temperatures. Those interested in the commercialisation of science in America, and later in Great Britain, saw that money might be made by using 'dry ice' which was the name given to this product. It is an interesting example of how profits are made by a discovery. All of us remember the old (*kulfi wala*) ice-man who did a trade in cheap ices carrying in heavy earthen or metal pots. It was hard work selling ice and heavy loads had to be carried on the shoulders of the ice-vendor. But a thing which is more effective than ice and is of less weight, namely solid carbon dioxide, makes it possible for ices to be taken round with much less trouble and makes it possible for 'Magnolia' or 'Happy Boy' companies to have a roaring business.

Making liquid carbon dioxide solid was comparatively simple. The second important step on the way down to lower temperatures was making air liquid. There is no need to give you details of the process, but it was done nearly half a century ago. Air was got in a liquid form, and while the process was being worked out, an invention which is very important for our everyday existence was made. The 'vacuum flask'—'thermos' as it is termed in the trade—was the invention of Sir James Dewar. He had need of a vessel in which to put the liquid air and hydrogen he was producing, so that heat from outside would have no effect on them. So he put two glassvessels one inside the other, joined together at the lip, and took the air out of the space between the two. Making vacuum flasks* in this way is now a great industry. And so is the making of liquid air, and from it oxygen, argon and neon. Great amounts of all these gases are used: oxygen is used for joining and cutting metals, and argon and neon for electric lights and signs.

From this description it can be easily seen by you how certain inventions have been of very great use, inventions which were only made in the first place for the purpose of getting lower and lower temperatures. Now it is only in our day that interest in the question of getting low temperatures has become so great. Thirty years back hydrogen gas was made liquid. Now hydrogen is an interesting substance, because in its chemical behaviour it is quite like a metal. So it seemed probable that liquid hydrogen would be a metal, like mercury,

and there were a great number of attempts to make it liquid. But unhappily, the liquid, when at last it was got, was not like a metal at all; it was a clear liquid like water. After that, naturally, less interest was taken in this question of very low temperatures. After all, the boiling point of liquid hydrogen is -258°C ., or only 15 degrees higher than absolute zero. In that short range of temperature, some of the most surprising discoveries of the present day have been made, particularly with respect to the properties of electric conductance.

INDIAN CHEMICAL AND PHARMACEUTICAL INDUSTRIES

The examples which I have quoted are not the exclusive monopoly of the European or the American countries. Workers in our own country have done research work which has found wide applications in industry. The name of Sir J. C. Bose himself stands high in that category. His ingenious experiments on the detection of electrical waves, which excited the attention and admiration of no less a scientist than Lord Kelvin, were pioneering experiments and led to the development of the "coherer" and other devices which have made wireless telegraphy a commercial possibility, and although Sir J. C. Bose's name does not figure in the technical instruments employed in large-scale practice, there is no doubt that he contributed much to the idea which culminated in the successful development of this marvel of our age. If we had an industrially developed India, the researches of Sir J. C. Bose on the properties of electrical waves should have been commercialised immediately and he should have been more widely known as the Marconi of India and the founder of one of the biggest industries in the world. Fortunately, there are some who still consider him as one of the most important contributors to wireless research.

If Indian researches have not been employed on a large scale, it is not because they are of no importance. This neglect is largely due to the luke warm interest of our Government in the past in these activities, an utter lack of appreciation on the part of our industrial magnates as to the possibilities of scientific research in relation to industry and the sophisticated and too philosophical a view which the scientists themselves have taken of their discoveries. Even in these difficult conditions, there are signs of the potent powers which lie hidden in our land. The inspiring genius of

* The reader may refer to SCIENCE AND CULTURE, 5, 694-5, 1930-40 for a detailed account of the development of vacuum flasks.

Sir P. C. Ray enabled him to sow the seeds of Indian industry which have now blossomed forth in the shape of the Bengal Chemical and Pharmaceutical Works Ltd., one of our largest chemical factories in India. I hope the faint and feeble voice of this great savant will not be ignored by the directors of this great organisation and side by side with the more alluring and enchanting side, namely, the preparation of pharmaceutical drugs, they will develop with equal vigour the less interesting, and from a business point of view, the more difficult, but from a long point of view, the most important and perhaps the most fundamental of all industries, namely the basic chemical industry.

No more fitting memorial to the services of Sir P. C. Ray can be raised by this country than the planning and execution of a programme of industrial expansion on the chemical lines. Fortunately the scientific researches of Sir P. C. Ray have been catalytic and have aroused widespread interest and enthusiasm in India and there are noticeable signs that even during, but certainly after, the war, we shall hold a proud position in the industrially and chemically developed countries of the world. The Tatas whose name counts as a magic word in industry have been pleased to direct their attention to this subject and the Tata Chemical Works at Mithapur promises a new era in our planned industrial programme under the leadership of Mr Kapilram H. Vakil. The efforts of the Alembic Chemical Works in Baroda, the activities of the Mysore Government, the Kashmir Government, Messrs. Shambhu Nath and Sons, Messrs. D. Waldie & Co., Messrs. B. K. Paul & Co., Messrs. Smith Stanistreet & Co., and the Baluchistan Government are all indications of the direction in which the tide is turning. The developments which are in the process of materialising in the near future will give a fillip to scientific research which no other movement has yet been able to impart.

NEED OF CO-OPERATION BETWEEN INDUSTRIAL FIRMS AND UNIVERSITIES

In this task, the universities will have to play a great part, because it is in their portals and laboratories that the wealth of talent, stores of learning and the treasures of imagination lie hidden. If industry had developed as fast as the universities, the importance of this contact would have been more easily and more quickly appreciated, but there is no

doubt that this appreciation is forthcoming and some of our universities have prepared themselves or are preparing steadfastly to capture fresh fields and pastures new.

In this connection, I wish to particularly pay a tribute to the universities of the Panjab, Calcutta, Bombay, Benares and Nagpur which provide facilities for technical training and industrial research. This movement has gathered momentum and I understand Aligarh and other universities are thinking along these lines. The Indian Institute of Science at Bangalore, under the able guidance of my friend, Dr J. C. Ghosh, is establishing itself as a premier institute for industrial research and promises to become a really living monument to its great founder, the late Mr J. N. Tata. The Bombay University has provided an excellent laboratory for chemical technology and textile chemistry and very valuable work is being done by Dr K. Venkataraman there. The Calcutta University has a very strong school of applied chemistry. It is also fortunate in having Professor J. N. Mukherjee who has done valuable work on physical chemistry which has been appreciated by industrial firms. There are many others whom I could name, but time does not allow me to enlarge the list. Their importance, however, is not lessened by the lack of reference on this occasion.

CHEMICAL INDUSTRY IN JAPAN

As an indication of what the more wide-awake nations of the world are doing for their industries, may be taken the progress which Japan has made in this direction after the 'China Incident.' I have drawn freely from the address delivered recently by Dr K. G. Kita, chairman of the Society of Chemical Industry of Japan as his account should be an eye-opener to Britain and to India.

According to Dr Kita, Japan's chemical industry has made such remarkable progress in recent years that new developments have been witnessed in almost all branches and some of them may now be said to have reached world level, being second or third largest production in the world.

It was during the last world war that the Japanese chemical industry attained amazing progress but still greater developments have been made under the stimulus of the China Incident; from which it may be concluded that a war, miserable as it is, does contribute to industrial development.

Fuel Industry : Special mention must be made of the success in the coal liquefaction test. In the summer of last year announcement was made of the successful establishment of a coal liquefying plant at Fushun. Thus, Japanese technical skill has accomplished a task that we believed to be the most difficult of all in the chemical industries.

By utilising German technical skill, tests are being conducted at several laboratories to produce synthetic petroleum oil from water gas. The Omuta plant (under Mitsui management) has nearly succeeded in this and actual operation will be started in the near future. This method is not a copy of the German process but the Japanese research has evolved new catalysts such as iron. Plant production is now being contemplated.

As regards liquid fuel, the importance of acro-nautic gasoline is being felt all the more in recent years. For this particular fuel a new method is being studied and developed because the available resources do not allow Japan to resort to the method used in America.

Metal Industry : The magnesium metal industry has been further developed and apart from the use of magnesium chloride from bittern, manufacturing facilities have been extended and a new process to use magnesite has been completed.

Aluminium : During the pre-Incident days alumite and alumina shale of Korea were in use for the manufacture of aluminium. Recently, however, it has been made possible to manufacture high-grade aluminium from these domestic materials and from the imported ore.

Nickel : While the refining of the imported ore is going to be industrialized in the near future, the matter of treating low grade domestic ore is receiving serious consideration.

Alloys : Japan has succeeded in producing and putting to practical use the super-duralumin with minimum tensile strength of 45 kilos per sq. mm. Production of the 13% chromium stainless steel directly from ore is another achievement in modern metallurgy. The refining of iron ore by means of high frequency has been introduced on the large scale. This method makes available the sponge ore which may be used for the manufacture of high speed and other special steels.

Synthetic Ammonia Industry : Remarkable development has been noted in the industry since

the outbreak of the Incident and the annual output now exceeds two million tons. Additional increase is under contemplation.

Manufacturing arrangements of nitric acid by oxidation of ammonia having been completed before the outbreak of the Incident, increased ammunition production has been accomplished.

In connection with the ammonia industry, manufacture of urea has been accomplished and the production is now believed to be sufficient to meet domestic requirements.

Silicate Industry : Special mention must be made of the manufacture of optical glass. Many years of study in the past have enabled Japan to produce every description of this glass sufficiently to meet their own demand. In this connection the 2-ton crucible for melting purposes devised in Japan has been highly spoken of internationally. Glass fibre is now produced on a commercial basis and considerable quantities are used as separators for accumulator.

Synthetic Resin : Synthetic resin industry is fast becoming Japan's second most important branch of chemical industry. From the standpoint of synthetic organic chemistry, attention was directed in the past mostly to dye-stuff and the like, but recently aliphatic compounds are receiving more attention and enthusiastic research.

Synthetic Rubber : Synthetic rubber of the thiokol series is already industrialized in various parts of the country, while that of the acetylene and butadiene series will shortly be produced by a new method.

Artificial Fibre : Production of artificial fibre, including rayon and staple fibre, now ranks first or second in the world. Their quality has been sufficiently developed to be put to practical use.

Production of another artificial fibre from soya bean has been industrialized, whereas research is well under way for the manufacture of fibre from alginic acid contained in sea-weeds.

Pulp : For the production of pulp, acerose trees were used in the past but recently this industry has been further developed by using broad-leafed trees, reed etc.

Synthetic Fibre : To complete with the nylon* developed in America, a new synthetic fibre has

* An article on this has been published in the Science in Industry section of this issue.

been developed, for which a technical test will shortly be conducted.

NEW CHEMICAL INDUSTRIES IN INDIA

These glaring accounts of Japan's industrial programme should make my countrymen naturally anxious to know as to our position as regards industry. Unfortunately this war is developing with such great rapidity that it offers little scope for those who wish to start *de novo* in the industrial fields. The benefits of this war will largely go to those industries which are already in existence and which are capable of expanding and adjusting themselves to the requirements and rapidly changing conditions of this war. The above statement does not imply that no new plants have been purchased or set up for some of our most urgent requirements for the prosecution of this war. In India several new plants are in the process of being erected and several others have already come into existence. For example, we have now in the country a plant for the manufacture of chlorine and bleaching powder (at Mettur Dam) and a plant for the production of nitric acid from synthetic ammonia (in Mysore). A big plant for the manufacture of benzene and toluene from coal is being put up at Tatanagar. Orders have been placed for a plant for the production of aviation lubricants in North India. These ventures are sufficiently big and their execution has meant Government encouragement and special facilities for shipping. These enterprises are being entrusted to those who have had sufficient experience of handling big industry.

This does not imply that the war offers no scope for service for the man with small capital, but it is such a gigantic war that the things which count in it must be purchased on a large scale, and hence the bigger industries capable of larger output are looked upon with a far greater degree of confidence for real service.

It must also be noted that, comparatively speaking, it is more a war of machines than of men with the result, that the supply requirements for perfecting the mechanisation are more urgent and immediate than the comparatively meagre requirements for equipping an ordinary soldier which used to be the most urgent concern of the army in previous wars and which India was able to supply readily. Although no gas has obviously been used in the war so far, no wise organisation of defence

can ignore the possibility of this weapon being employed at any stage. India produces large quantities of cocoanut and both Ceylon and the South Indian Provinces have done well in the cottage industry which specialises in producing cocoanut shell charcoal in the unactivated form. There is however in my opinion, a tremendous scope for India to make a really substantial contribution to the war effort by organising a planned cohesion of labour and industry. In a restricted manner even now a great deal of work for the supply of goods to the army is done through approved contractors who get bits of works accomplished here and bits elsewhere. This is merely indicative of what can be done if these units spread all over the country are knit in a chain of systematic organisation. The greatest scope for India lies in her ability to make good by indigenous production what now constitutes a shortage in Indian industry owing to restricted imports, and this presents a vast field of investigations for the technical man and the universities.

MANUFACTURE OF TEXTILE MACHINERY

If we examine this question a little more deeply, we are impressed with the vast possibilities which present themselves to us. Let us fix our attention to the requirements of the Indian textile industry. This industry has demonstrated the industrial abilities and acumen of our Indian businessmen. It is too much to expect that as a consequence of the success of this industry, India will immediately start on an ambitious programme of manufacturing textile machinery. It may come about some day but it must be remembered that there are hundreds of auxiliary articles in this industry which must be manufactured here. For example, the textile industry needs a very large number of bobbins and shuttles. India which is renowned for her raw materials abounds in forests which produce all sorts of timber. Use can either be made of the timbers which have been pronounced to be of sound quality for the above purposes; alternatively, the timbers may be given well-known suitable treatments to give the desired qualities. Work of this type requires short-range industrial research. This research can be of a short range character because it is open to us to either discover or try well-known methods on Indian woods and a proper selection can be made after experimentation. The textile industry presents many such interesting investigations; for example,

producing of pickers, varnishes for healds and the manufacture of substitutes for fibre baskets and many more things of a similar type. It is possible for us to develop these and other industries so that the already successful textile industry may grow still more vigorously and may suffer no set-back from shortages experienced now owing to the restrictions on imports. The textile and sugar industries ought to be able to inspire industrial development in this country, as the marketing facilities for the auxiliaries needed by these ought to present no formidable obstacles.

BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The Board of Scientific and Industrial Research and workers in the field of industrial research are alive to this and many investigations have been undertaken with a view to introducing the manufacture of auxiliaries in industries which have become already firmly established, as the most immediate service which research can render is to make the existing organisations equal to meet any emergency. It is fortunate that there exist in India such institutions as the textile chemistry department in the Bombay University, the Cotton Technological Laboratory, Matunga, and the Imperial Institute of Sugar Technology, Cawnpore, and they are helping the textile and sugar industries in every possible way.

For obvious reasons it is neither possible nor desirable to mention the various problems of shortages which are engaging our attention. It will suffice to say that research work of the Board is largely carried out under the following fifteen research committees:

1. Vegetable Oil Committee.
2. Fertilisers Committee.
3. Drugs Committee.
4. Plastics Committee.
5. Sulphur Committee.
6. Scientific Instruments Committee.
7. Graphite, Carbon & Electrode Committee.
8. Molasses Committee.
9. Glass & Refractories Committee.
10. Vegetable Dyes Committee.
11. Fuel Research Committee.
12. Cellulose Research Committee.

13. Essential Oil Committee.
14. Metallurgical Research Committee.
15. Naturally Occurring Salts Committee.

The last committee has been set up with a view to exploring the possibilities of increasing the production of pure sodium sulphate, ammonium chloride and magnesium chloride from naturally occurring sources.

From this one can judge the large ground which our programme of research covers for Indian industry. Besides the problems of the Supply Department and investigations for several established industries, which pay for their work, the work under Government covers investigations on several industrial wastes such as jute waste, grasses, oilseed cakes, molasses, spent tans etc. Investigations on the extraction of useful materials from plant products, particularly active principles from indigenous drugs, are being actively pursued and it is hoped that several drug shortages will be met as a result of the investigations which are being financed by Government at several places in the country.

The successful solutions of some of these problems will lead to the development of new industries. At the last meeting of the Board, it was decided to make known to the industrialists and would-be investors that the process for making casein plastics developed by the department of industrial chemistry at Hyderabad, Deccan, was open for exploitation. The Board is asking the Industrial Chemist at Hyderabad to collaborate in its development on a large scale. It is for those interested in financing new ventures to take advantage of the information which Government are able to place at their disposal on request.

The present war has once again brought into the forefront the question of the introduction of basic chemical industry in this country and it is fortunate that the Tatas, who have done so much to the steel, vegetable oil and cheap-power production industries in India, have taken up seriously the question of manufacturing important chemicals. Even during the war, they are doing all they can to expedite production. The introduction of basic chemical industries is a question of policy rather than research and the necessary capitalists should come forward to help the country. Now that the Tatas have taken up the manufacture of steel of all kinds, it should be possible to develop the industry for the manufacture of surgical instruments. The

problem of sulphur and sulphur compounds has engaged the attention of the Board and the following lines of attack are being pursued.

1. Attempts are being made to explore the possibilities of mining sulphur. Its occurrence has been reported in Baluchistan and Sind and the Geological Survey under Dr Fox have sent parties to investigate the possibilities of obtaining sulphur in this way.

2. The Tatas were apprised of the fact that sulphur recovery during the manufacture of benzol and toluene by their plant shortly to be installed will be of national importance.

3. Enquiries have been addressed regarding the patent position etc., for utilising the sulphur dioxide set free during certain metallurgical operations particularly during the manufacture of copper from copper pyrites.

4. New processes for utilisation of iron pyrites and other sulphur bearing minerals are being investigated.

5. Sulphur compounds available from coals and oils are being examined for their utility in trade.

There is no doubt that the activities of the Bararee Coke Works and those of Turner Morrison & Co. which manufacture benzene, toluene and phenol and the proposed installation of a big plant for the recovery of the above products in Tatanagar will eventually lead to the production of innumerable organic compounds and drugs and may eventually turn out to be the forerunner of a synthetic dyestuff and drugs industry. Just as round about the Tata Iron and Steel Works at Jamshedpur various subsidiary industries have come into being as its offsprings, so will new and powerful subsidiary industries grow round Bhadravati in Mysore and coalfield areas in Bihar and the Khewra salt deposits in the Punjab. The Indian investor should particularly investigate the possibilities of developing uses for the raw materials whose exports were so large from this country that their disposal now constitutes a serious problem. In this category may be mentioned the vegetable oil-seeds, bones and skins and leather wastes. It is imperative that India should develop those industries in which oils and oilseeds can be consumed. The utilisation of bones and leather wastes should also result in the development of several subsidiary industries. With the passing of the Scandinavian countries into German

hands the production of newsprint and paper pulp in India has acquired an altogether different aspect and the possibilities in these lines are being explored.

It is interesting to note that scientific research has already brought some laurels for the investigations. It is in the fitness of things that I should refer here to the development of neutral glass industry in this country particularly as it is largely the outcome of the investigations of one of the close associates of the Bose Institute, namely Professor N. C. Nag and his collaborators. This is no mean achievement and I offer my congratulations to the Institute and the Professor for this notable contribution.

Dr S. Krishna of the Forest Research Institute has discovered a minor forest product which will yield large quantities of pectin at extraordinary low prices and this research is ready to go for large scale development immediately.

The luminous paints of non-radio active origin from Indian ores and minerals developed in my laboratories have reached the production stage and the premier paint firm in India, namely Messrs. Shalimar Paint Colour and Varnish Co., Ltd., have agreed to put them in the market subject to approval by Government.

A wood treating process for which patents have been lodged utilising the impregnation of naturally occurring resins and imparting to woods qualities of hardness, toughness and resilience has reached the pilot plant stage and it has been favourably reported upon. It can impart to cheap woods qualities one looks for in good quality woods.

Attempts are being successfully made to obtain from chlorinated rubber and other products, transparent films of great stability which bid fare to rank as suitable competitors of the cellulose acetate films.

Dr Siddiqui has developed a technique for the manufacture of varnishes and paints from the Bhilawan nuts and the trade has expressed great satisfaction with the results obtained. The films of varnish which are obtained from this material are more flexible and resistant to shock than any such product in the market.

By a suitable treatment of paper with certain resins, it has been possible to impart to it the property of insulating fibre boards both as regards strength and flexibility and there are many enquiries from trade regarding its large scale manufacture.

PLASTICS

One of the most fascinating fields of research in the industrial line is in the domain of plastics. As some of the most important plastics may be mentioned the following: bakelite, casein, shellac, glyptol resin, vinyl resin, cellulose acetate and cellulose nitrate, bitumen and rubber.

Some of these resins are available to us as natural products in India. Fortunately research has brought out the possibility of developing many other plastic materials in India. Of these, special mention may be made of resins from vegetable oils, bagasse and molasses, coffee beans, soya beans and a host of other cheap seeds available in abundance. Research is being financed to produce urea, malamine and formaldehyde without which the shellac resins cannot compete with bakelite. These industries present attractive possibilities for a financier who may wish to make a name for himself and render real service to the country. My friend, Dr H. K. Sen at the Lac Research Institute at Ranchi will feel immensely relieved if his task is made easier by the Indian industrialists themselves. There is no article of construction or art which cannot be made from plastics. The discovery of nylon in America, a resin made from naturally occurring mineral products has enhanced the reputation of plastics as substitutes for metals because nylon fibre with all its elasticity and softness of silk has the tensile strength of steel. The problem of moulded aeroplanes in plastic materials is being aggressively attacked by four aircraft companies in the United States. One of these research groups is working at the Mellon Institute under a fellowship established by Glen N. Martin & Co. The other group is working under the plastics section of the National Bureau of Standards and the Army Air Corps and

the Navy Bureau of Aeronautics are showing great interest in the large-scale production of moulded aeroplanes for defence purposes. Plastic plywood construction assures long life for aircraft which will maintain its stable dimensions and weather resistance without appreciable depreciation in varying climates. Smooth contours of compound curvatures and splendid aero-dynamic features are attributed to the moulded aeroplanes so far produced for private use. India with her vast natural resources and varied sources for the production of plastic materials is an ideal country for this development.

Further progress has been made regarding the use of vegetable oils for lubrication purposes. The use of vegetable oils as diesel fuels is being thoroughly examined on a large scale from the economic standpoint, particularly, as the export of vegetable oils during the war is practically at a standstill.

Let us not forget that scientific and industrial research in this country has its handicaps. We are overburdened with all sorts of other duties. Our trade and our laws are occasionally not quite helpful, nor can it be said that political considerations do not come in the way of some of the investigators.

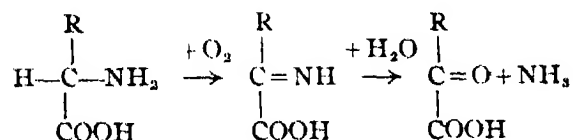
We must however have the patience, faith and courage of the noble founder of this Institute. I have every reason to hope that with the goodwill of the universities and the trade we shall be able to do our duty to our country. The Sir J. C. Bose Institute will no doubt play its part in the programme. The Institute is fortunate in having as its director one who is a well-known figure in international science and whose solicitude for the industrial prosperity of our land is as great as that of Sir J. C. Bose himself.

Biological Synthesis of Amino Acids*

N. B. DAS

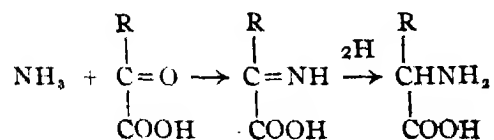
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THE researches of Neubauer (1910), Knoop (1910) and Krebs (1933) are chiefly responsible for our present knowledge of deamination of α -amino acids in animal tissues. The deamination is oxidative whereby imino acid is formed as an intermediary product, ammonia and keto acid being the end products:—



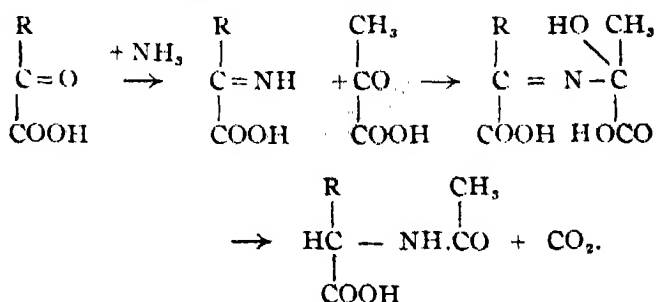
From feeding experiments Knoop (1911) suggested that amino acids are formed from keto acids. Embden (1910) and Dakin (1914) confirmed it by perfusion experiments with liver. More recently Neber (1935) found that amino acids are built from NH_3 and keto acid in liver slices.

Knoop discussed two hypotheses for the mechanism of synthesis of amino acids in animal tissues. The first was reduction of imino acid. This hypothesis of Knoop and Oesterlin (1925) was from a pure model chemical experiment, where amino acid was built (nonenzymatically) by the reduction of imino acid (*i.e.*, a mixture of ammonia and keto acid) by means of catalytic hydrogenation or by reduction with the help of cystein or ferrous sulphate (1927).



The other hypothesis of Knoop (1925) is the formation of acetyl derivative of amino acids from any

keto acid, NH_3 and pyruvic acid. He gave the following scheme for the reaction:—



This acetyl amino acid is then hydrolysed to amino acid. This hypothesis of "acetylamination" has later been confirmed by Du Vigneaud and Irish (1938). Krebs (1936) is also of opinion that pyruvic acid acts as hydrogen donator to imino acid whereas other amino acids fail to do this.

Now in order to understand the mechanism of synthesis we must discuss the mechanism of oxidative deamination of amino acids in more details.

The enzymes responsible for the oxidative deamination of amino acids are richer in kidney, liver and intestinal mucosa and weaker in other tissues. In intact tissues both optical isomers of α -amino acids are deaminised while in cell-free extracts only the unnatural form is attacked. Molecular oxygen only acts as acceptor of hydrogen while redox dyestuffs even of higher potential are much worse as acceptors of hydrogen.

The cell-free enzyme system attacking the unnatural isomers of α -amino acids was reinvestigated by the present writer (1936). It was found that this enzyme required for its activity the co-operation of a thermostable coenzyme which occurs in animal tissues and yeast. This coenzyme was not identical with any of the known coenzymes like di- and triphosphopyridine nucleotide, alloxazine nucleotide,

* Adapted from a lecture delivered at the Biochemical Society, Calcutta.

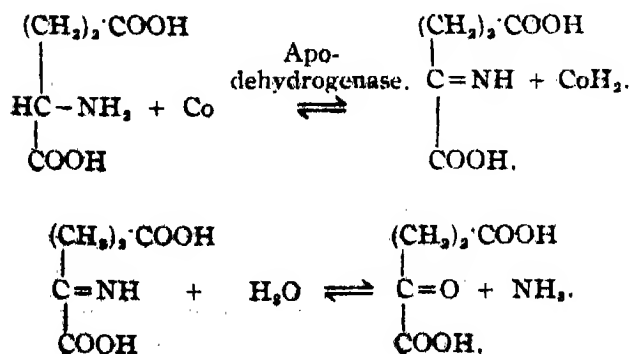
adenosin nucleotide, etc., and was very sensitive to ultraviolet light. This coenzyme not only activated the oxidation of d-amino acids (a) by molecular oxygen, but also activated the anaerobic reduction of a redox dyestuff like 2:6 dichlorophenolindophenol in presence of the purified enzyme system. Attempts were also made for its purification and some of its chemical characteristics were also described by the present writer (1936, 1938).

About this time this work had to be discontinued owing to other pre-occupation, when Warburg (1938) and Straub (1938) in Keilin's laboratory took up this work. This coenzyme has later been reported by Warburg to be flavin-adenine dinucleotide. Since the isolation of this dinucleotide much work has been done on its rôle in respiratory systems which are beyond the scope of this article.

The mechanism of deamination of glutamic acid was found to be different from that of other α -amino acids. This amino acid alone was found by Adler *et al* (1938) to be dehydrogenated in animal tissues by a specific enzyme system which required the presence of cozymase or diphosphopyridine nucleotide for its activity.

It was also found by Euler *et al* (1937) that l-glutamic acid is dehydrogenated in yeast by a specific apodehydrogenase* and co-dehydrogenase II (triphosphopyridine nucleotide).

The problem of glutamic acid dehydrogenation in animal tissues was taken up for reinvestigation. We found that liver apo-dehydrogenase was active in the presence of either co-dehydrogenase I or II forming α -iminoglutaric acid and dihydrocodehydrogenase I or II, the imino acid spontaneously decomposing into α -ketoglutaric acid and NH_3 .

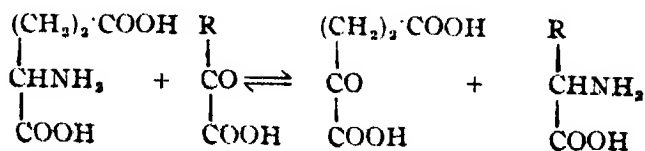


* Holo-dehydrogenase = Apo-dehydrogenase + Co-dehydrogenase.

These reactions were reversible, the equilibrium being in favour of the glutamic acid (Adler *et al*, 1937 and Euler *et al*, 1938). It was then easy to synthesise glutamic acid from the equivalent amount of α -ketoglutaric acid, ammonia and dihydrocozymase (CoH_2) in presence of the specific apo-dehydrogenase. "Glutamic acid dehydrogenase" is thus an enzyme which synthesises glutamic acid in the organism by the reductive fixation of ammonia on to α -ketoglutaric acid. This reaction of "Reductive amination" of α -ketoglutaric acid could also be successfully linked with dehydrogenation of glucose and alcohol. Since the reduced codehydrogenase (CoH_2) and apo-dehydrogenases are only in dissociated equilibrium, the hydrogen remains quite labile.

Now the question arises if glutamic acid dehydrogenase alone is reversible or d-amino acid oxidase also is reversible. We (Das and Euler, 1938) tried to synthesise alanine from pyruvic acid and ammonia with reduced neutral red as donator of hydrogen, in presence of unpurified enzyme preparation. We found rapid reoxidation of the reduced dye *in vacuo* only when ammonia was added to pyruvic acid, suggesting the synthesis of alanine but alanine was not actually estimated.

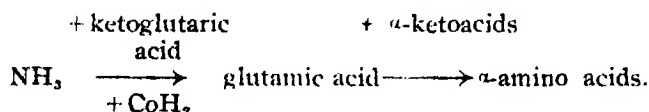
A very interesting fact has been revealed by the researches of Braunstein and Kritzmann (1937) who have found that many animal tissues contain a highly active and reversible enzyme system by means of which the amino group of glutamic and aspartic acid can be directly transferred to α -keto acids with the formation of corresponding α -amino acids; and α -ketoglutaric and oxaloacetic acid result respectively.



It may be mentioned here that such a reaction was first observed at Prof. Szent-Györgyi's laboratory. He observed that oxaloacetic acid disappears very rapidly in presence of glutamic acid and a tissue extract. This unusual rapidity of the reaction drew his attention. This reaction was many times used by me (1937) to remove oxaloacetic acid from the sphere of reaction. By this interesting discovery the specific fixation of NH_3 on α -ketoglutaric acid has thrown a new light on biological synthesis of amino acids.

Glutamic acid thus formed by reductive fixation of NH_3 on α -ketoglutaric acid, transfers its amino-group to other α -keto acids, formed as intermediary products in normal carbohydrate metabolism, to form corresponding α -amino acids according to the above reaction of Braunstein and Kritzmann.

The system ketoglutaric acid \rightleftharpoons glutamic acid thus acts as a system for binding NH_3 which is ultimately used in the synthesis of other amino acids over the following reaction:



This mechanism has been found to occur in animal as well as in vegetable tissues. Our present investigations have revealed that glutamic acid is much more active than aspartic acid in donating their amino groups to pyruvic acid both in animal and vegetable tissues under our experimental conditions. Investigations are in progress to study the mechanism of this reaction.

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PRESSURE OF SAP-CIRCULATION IN PLANTS

The circulatory mechanism for sap in plant remains still unexplained. Neither the capillary theory nor the suction by the process of evaporation at the leaf can explain the rise of sap as high up as 350 ft. in tall trees. It appears that there is some pumping mechanism in the living plant which circulates the water and sap to any part of its branches. Dr Philip White of the department of animal and plant pathology at the Rockefeller Institute has recently made an interesting measurement of the pressure exerted by the roots of plant in circulating saps up. Tomato roots no bigger than a piece of store twine have a pumping mechanism capable of developing a pressure of 90 lbs. per sq. inch. This and many other roots can survive and grow normally in a vessel of water containing dissolved plant food. The root was partially inserted in a narrow bent upward tube (capillary manometer) and anchored firmly in place with a rubber collar, the other end of the root being immersed in the nutrient liquid. The root then secreted water into the tube, recording a change of pressure. By this method Dr White measured a pressure of 90 lbs. per sq. inch. This however, represents the limit reached by the experiment rather than the limit of root capacity. When 90 lbs. were attained, the root was still pumping and Dr White is of opinion that the pressure cannot be less than 150 lbs. and is probably more.

This is an interesting and important fact of observation, but it does not explain 'how' the pumping is actually in process.

Bose Research Institute

DR D. M. BOSE presented the director's report of the Bose Research Institute before the 23rd Anniversary Meeting held on November, 30 last. Investigations are undertaken in the following departments: plant physiology and genetics, bio- and agricultural chemistry, physics and bio-physics, zoology and anthropology.

Plant Physiology and Genetics: Evidence has been collected which go to show that the pulsatory activity of the leaves of *Desmodium gyrans* which was the subject of a classical investigation by Sir J. C. Bose is due to photosynthesis of carbohydrates by the motile leaf. The pulsatory activity in the dark depends on the amount of sunshine received by the leaf during the day. In the dark the activity can be prolonged beyond this period by adding glucose to the water in which the leaflet stem dips.

The study of the effect of auxins on root formation in plants is being pursued successfully. The carbohydrate metabolism and histology of the formation of roots in *Impatiens* (Dopati) has been studied. Experiments with parthenogenetic fruit setting has been successful with pumpkin, by treatment with 0.1 per cent. concentration of naphthalene acetic acid. Roots were formed in the marcotte of young mango plants within a fortnight of the treatment with auxin and plants were raised successfully from 80 per cent. of them. This gives a much better method of plant propagation than by inarching.

Investigations on the variations of the carbohydrate and nitrogenous substances in jute plant with growth and the effect of artificial manures on the growth of the plant are being continued. These investigations will throw fresh light on the controversial subject of the phenomenon of translocation in higher plants.

Investigations have also been carried out on the boron requirement of jute plants. It has been found that a definite optimum concentration of the trace element boron, between 0.01 ppm. to 0.1 ppm., is necessary for the growth of jute plants in sand culture. Further the 'dieback' effect observed under certain condition in jute plant is not due to a deficiency of boron in the soil. Cytological studies of microsporogenesis in jute, sunhemp and flax have been undertaken.

Extensive investigations were carried out during the last two years to vernalise (accelerate the flowering date of) some of the Indian economic crops such as wheat, barley, oat, pea, cicer, mustard and some varieties of *aus* and *aman* paddy. It has been found that the Russian method of pre-sowing cold treatment which is successful in case of temperate climate crops does not give positive results in case of majority of the Indian crops so far investigated and which therefore require different methods of treatment. Some positive results have already been obtained in case of wheat where the methods of treatment developed at the Institute have increased the earliness of flowering by 15 days as compared with the non-treated ones.

Bio- and Agricultural Chemistry: The metabolic drifts of mangoes and guavas, as illustrated by the response of the various chemical substrates under different environmental conditions such as the fruit on the tree, in different storage conditions and under artificial ripening process in an atmosphere of ethylene, have been investigated.

The catalase and oxidase activity in mango throughout its lifecycle on the tree from fruit-setting to ripening has been thoroughly investigated. The intercorrelation between rate of respiration and oxidase and catalase activity was investigated and a positive correlation was found to occur during ripening of the fruit and also in fruits subjected to various chemical respiratory stimulants and depressants.

The presence of sorbitol has been definitely established in the mango. From the Indian plant *Leucasaspera* (Drona) a crystalline organic principle in a state of chemical purity has been isolated.

Recently Bhagvat and Hill have shown the occurrence of cytochrome oxidase in higher plants. Present investigation at this Institute have shown that the presence of the two enzymes, Succinodehydrogenase and Fumarase, together with the facts that cytochrome and its oxydase are also present in vegetable cells suggest that "Cytochrome system" or "Warburg-Keilin-Szent-Györgyi system" also takes part in vegetable respiration.

Investigations have also been undertaken to study the mechanism of synthesis of starch and the de-amination of α -amino acids in vegetable tissues. Attempts have been made recently here to study

whether the second reaction of indirect phosphorylation exist in vegetable tissues. In a few cases only evidences have been found to show that mechanism of indirect phosphorylation also exist in vegetable tissues.

Investigations on filarial tissue mentioned in last year's report have been continued in collaboration with Dr S. Sirkar of Calcutta Medical School. Further analysis are being made to study the protein, carbohydrate and fat content of both filarial as well as normal tissues. The progress of this work has been very slow as sufficient tissues are not available.

Physics: A series of investigations with photographic plates kept at Darjeeling (7,000 ft.) and at Sandakphu (12,000 ft.) on the origin and nature of the particles which produce heavy ionisation tracks on these plates have led to the conclusion that the primary rays are chiefly neutrons. A mass of evidence has accumulated which show that the secondary particles observed in the photographic emulsions are mesotrons which are created as showers chiefly by the action of the fast primary neutrons.

Investigations are being further continued by sending plates to Phari Jong (elevation 14,500 ft.) in Tibet to detect doubly charged protons, produced by the passage of the high energy cosmic ray protons through hydrogenous matter (e.g., 20 cm. of water), whose occurrence is predicted according to recent theories of Bhabha and Heitler.

The low-energy neutrons present in the atmosphere at different altitudes up to Darjeeling has been studied with the aid of ionisation and proportional counters filled with boron trifluoride.

A theoretical investigation on the reality of the second maximum in Rossi's curve has shown that depending upon the geometrical arrangement of the counters the second maximum either becomes prominent or disappears from the Rossi curve.

Study of radioactive atoms produced by the bombardment by α -particles or by slow neutrons is being continued. Several radioactive organo-bromo compounds have been prepared, and the strength of different types of bindings in such compounds has been investigated by the use of radioactive bromine as trace element. A low-voltage discharge tube neutron generator is under construction which is expected to give a neutron production equivalent to that produced by one gram of radium.

The possibility of neutron formation in course of stellar evolution as discussed in recent theories of Zwicky and Baade has been followed up and the physical conditions under which they can be formed

have been studied. An attempt has been made to reformulate the theory of Vogt and Russel on the course of stellar evolution in light of Bethe's theory of energy production in stars.

A formula for the derivation of the polytropic index (n) has been given by assuming a general law for the dependence of opacity co-efficient and the rate of energy generation in stars on temperature and density.

In view of the doubts thrown on the reality of dispersion in water of ultrasonic waves found by one of our workers, the investigation has again been repeated with a new set of apparatus; the results obtained are in agreement with those obtained previously. Variations of velocity of the ultrasonic waves in different sets of liquid mixtures have been studied leading to the discovery of certain maxima and minima velocities in them.

Bio-physics: The recording of electrical rhythm of the brains of unanaesthetized human beings through the unopened skull under different experimental conditions is being continued. As part of the expansion work lately undertaken with the electroencephalographic machinery, the only one of its kind in this country, brain rhythm is being recorded from Calcutta Deaf and Dumb School students.

Zoology: Different varieties of fishes are being reared in experimental tanks and their habits and outer sex characters studied. In certain species it has been possible to identify the female and to extrude mature eggs from them by suitable manipulation.

Investigations on the cause of sex differentiation and caste distinction in the variety of red ants *Ecophylla smaragdina* Fab. has been continued. Artificial formicaries have been built to study their behaviour under controlled environmental conditions. The parthenogenetic production of males from unfertilised eggs of the queens has been established. It has been found that in colonies containing only workers, which possess well-developed ovaries filled with eggs, larvæ of queens appear with the advent of summer, the cause of which has been supposed to be tropogenic (due to influence of environment.).

Anthropology: Blood group investigations have been carried out amongst the Oraons. With the assistance of the authorities of the Calcutta Medical School blood group investigations of the Vaidyas of Bengal and of the twins born in the hospital are being carried. Twin pedigrees and also pedigrees of various hereditary anomalies are being collected.

Notes and News

Temperature Distribution in the Lower Stratosphere

OBSERVATIONS of temperatures at heights between 18 and 25 kilometres over different stations in India have been recently discussed in a paper by Mr M. W. Chiplonkar, in which he deals with the increase of temperature with height over tropical India. The India Meteorological Department has been successful in obtaining temperature data at great heights. The results of twenty-six ascents, ten at Poona (Lat. 18°) and sixteen at Agra (Lat. 27°) have been recorded. Most of these ascents were made during April-November and at a time when the sun was possibly below the horizon and when the balloon rose into the stratosphere, so that the temperature data obtained were unaffected by solar radiation. No other country can show a comparable amount of data free from this likely source of error. Over Poona, the rise of temperature is largest around 21 kilometres where it is about 4° to 5°C per kilometre. The above appears to be a permanent feature of the stratosphere over tropical India. Comparing the result with that obtained from similar observations over other parts of the world, *e.g.*, at Munich (48°N), an analogous rise is detected but it begins at a lower level, is much smaller and observed only during the summer half of the year.

Land Reclamation and Conservation of Forest Resources in U. S. A.

VARIOUS aspects of American conservation schemes were discussed at the eighth session of the American Scientific Congress meeting held this year at Washington. The movement towards conservation begun under Theodore Roosevelt nearly half a century ago with the establishment of the Bureau of Reclamation and the National Forest Service has received a great impetus under President Franklin Roosevelt. The Bureau of Reclamation has carried forward its programme of irrigation in the west. One third of the United States—the west—is arid or semi-arid and much of this is desert. Streams dry up periodically in the summer and without irrigation no

agriculture is safe. Even irrigation is unsafe without storage reservoirs. At the present day, twenty million acres have been brought under irrigation in the west, through individual enterprise, co-operative endeavour and State and Federal aid. Due to increasing size and complexity of irrigation works, the task of water conservation and land improvement has now devolved upon the Federal Government. Beneficiaries however pay the cost of the work carried out by the Bureau of Reclamation. The results achieved by the Bureau of Reclamation will be judged from the following figures. The constructive work of the Bureau has resulted in 53,000 new farms and 258 new cities and towns where nearly 1,000,000 people live. Out of $42\frac{1}{2}$ million acres which the Bureau considers possible of reclamation, twenty million acres are already under irrigation, $2\frac{1}{2}$ million are in the present construction programme leaving another 20 million for future work.

The forests of United States and Canada were cut heavily to supply world markets and to meet the needs of growing local populations which naturally resulted in devastation and deterioration of the remaining forests. The conservation programme now aims at rehabilitation of these forests to restore them to their potential continuous productive capacity. The urgent necessity has been felt of educating people in general and forest-owners in particular as to the value of forests and the basic principles of a forest policy and of imparting broader knowledge of suitable technique for harvesting and processing forest products, in order to minimise waste and enable efficient operation and making adequate provision for research on problems relating to better protection of forests from fire, insects and disease. The co-operation of all American countries has been invited and the starting of a Pan-American Forestry Institute has been suggested.

Success of Educational Radio in U. S. A.

A PERIOD of four years was completed on June last year, since the Smithsonian Institution undertook a programme of educational radio broadcasts with the

object of increasing and diffusing knowledge among the ordinary people. The title of the popular series of broadcasts was "The world is yours". In addition to science, the broadcast dealt with exploration, history, engineering, invention and art. Since the programme was started in 1936, it has expanded from its original 27 stations to a network of 82 stations covering the whole country. From an analytical survey of all the programmes given on all the stations it was learnt that the Smithsonian dramatizations received the highest rating of all serial programmes on the air. To promote further this increase and diffusion of knowledge, the educational values of these programmes is preserved by the Educational Radio Script Exchange, U. S. Office of Education. Hundreds of schools and civic groups are using these scripts for production by radio and over sound systems.

Geomagnetic Research in the Americas

DR J. A. Fleming of the department of terrestrial magnetism, Carnegie Institution of Washington gave a historical review of the collection of geomagnetic data in the western hemisphere in a paper read before the eighth American Scientific Congress. The Americas with their vast areas, their great river-systems, their mountain ranges rising to elevations second only to the Himalayas and their surrounding Atlantic, Pacific and Southern Oceans offer wide and fertile field for geophysical investigations. Reliable data in the western hemisphere began to be obtained from about 1700, when the historic oceanic magnetic survey under Edmund Halley took place. The magnetic equator crosses Peru and Brazil in the western hemisphere. One of the agonic—the line along which the compass points true north—passes a little to the west of north from Montevideo through Brazil, western Venezuela, Cuba and the United States of America. Much later in 1802, Alexander Von Humboldt located the magnetic equator in the Andes near Lat. 7°S .

During recent years the Governments of Brazil, Argentine and the United States have been most active in their magnetic surveys. After the formation of the department of terrestrial magnetism of the Carnegie Institution of Washington in 1904 and the inauguration of the world magnetic survey of land and sea in 1905, co-operation has been received from all American governments, which has made possible to open many new stations to supplement the data already obtained by the department. Of the 6,000 such stations occupied nearly 200 expeditions on land during 1904-40 and of upward 4,000 stations at sea on the ship 'Galileo' (1905-8) and the 'Carnegie' (1909-29) at least one-third are in the western hemisphere. The data obtained permit reliable dis-

cussions of the distribution of the earth's magnetism and of mysterious variations of its elements from year to year.

Naturally because of later start, Europe at the present day has a great majority of the permanent magnetic observatories, but the Americans also have established some fifteen laboratories well-distributed over the Continent.

Irrigation Research

THE Annual Report (Technical) of the Central Board of Irrigation, India, for 1938-39 describes investigations carried out at the various irrigation research centres in India to study and solve problems connected with irrigation and river control in India.

Experiments with models are being carried out at the Central Irrigation and Hydrodynamic Research Station, Poona to study the behaviour of rivers and evolve methods of training them so as to prevent destructive action. In connection with reduction of silting the Lloyd Barrage Canals, a model of the river Indus and the Lloyd Barrage at Sukkur is being studied. Experiments have also been made to devise means of protecting the bund on the right bank of the Sarda river above the barrage at Banbassa. Model experiments on erosion at a sharp bend of the Watrosk river near Kaira town have suggested suitable river protection and correct siting of a bridge proposed across the river. The Delhi-gate pumping station on the right bank of the Jumna is faced with danger because eighteen years after its construction the river now shows a preference for the left bank. Measures to induce the river to flow along the right bank near the pumping station were studied on a model.

Experiments with a model of the river Ganges near the Hardinge Bridge on the Eastern Bengal Railway in connection with investigations of movements of the river were continued. Means of preventing scour round the piers of a proposed railway bridge across the Brahmaputra river at Amingaon were studied on a model. Several submersible bridges in the Central Provinces are damaged during floods, and model studies were carried out to investigate uplift pressures on the deck slabs of the bridges during high floods. A detailed account of some of the important practical problems dealt with at the station is expected to be published in a subsequent issue.

The Punjab Irrigation Research Department are carrying out investigations for the improvement of earth roads with sodium chloride. A cheap sodium carbonate cum mud plaster has been evolved for mud houses and also for plastering watercourses to

prevent loss of water by seepage. Two important investigations with models of rivers near weirs, of the Panjnad river downstream of the Panjnad weir where considerable bank erosion is taking place, and the other of the river Chenab at Khanki weir where the vagaries of the river are causing difficulties in feeding the canals, were also carried out in the Punjab. Investigations into the rise of subsoil water-table, and the appearance of salt on the surface have established that there is no connection between water-logging and the appearance of salt on the land surface, as there are cases where salts appeared on the surface though the water-table was 40 ft. below the ground. Several salt-affected areas have been taken up for reclamation investigations, and reclamation has been successful when carried out in the early stages of salt appearance. The Irrigation Research Division of the Bombay Irrigation Department is experimenting with irrigation using sewage effluents which has brought about a decided improvement in the texture of murmur black soils of the Deccan. In the United Provinces the main investigations are concerned with losses by seepage from canals and watercourses and studies of various types of lining to prevent seepage. Means of restricting and controlling silt entry into the smaller canals were also studied.

Sir J. C. Bose Memorial Lecture

DR S. S. Bhatnagar delivered the third Sir J. C. Bose Memorial Lecture at the Bose Research Institute on November 30, last. His subject was 'Scientific Research and the Future of Indian Industry'. The text of his lecture is published elsewhere in this issue. At the outset he recalled his association with the Indian scientists. He said :—

"I value this opportunity all the more as it presents to me a befitting occasion for recalling my associations with the great Indian scientist. I first met him in the year 1912 when he was invited by the Panjab University to deliver a course of lectures on his researches. I was then a student of the Dyal Singh College, Lahore. Professor Ruchi Ram Sahni was the secretary of the College and on that occasion the host of the late Sir J. C. Bose. As Professor Sahni has been interested in me from my very infancy owing to his great friendship with my father, he suggested that I and a few others should help Sir J. C. Bose in his demonstrations at the University Hall where the University had arranged these lectures. Sir J. C. Bose was a born artist and very punctilious and critical in his selection. He examined and tested all of us who were sent by Professor Ruchi

Ram Sahni to help him in the demonstration work and finally selected me as the only one he might need. Unconsciously or may be consciously, for he was a great seer, he laid the foundation of my career as a student of science, for I valued the trust he reposed in me and my young heart beat with joy at this recognition from the then greatest hero of science in our land. After Sir J. C. Bose's Lahore visit I lost touch with him. I was a struggling young student, while the fame of Sir J. C. Bose had reached the zenith of its glory during the years 1912-1918 and I dreaded coming too close to him almost like the Hindu devotee who would adore but not pollute by touch his beloved deity.

Chance threw us together again, for in the year 1919 soon after the war I proceeded to England to work under the inspiring guidance of Professor F. G. Donnan at the University College, London. The two years of my stay in England (1919-21) were memorable, for they brought me into contact with all those who have contributed so much to the ushering in of the age of science in this country. Not only did I meet Sir J. C. Bose again, but I came in contact with Sir C. V. Raman, Sir P. C. Ray, Profs. M. N. Saha, J. C. Ghosh, J. N. Mukherjee, K. G. Naik, S. Datta, S. Krishna, H. P. Chaudhuri, N. R. Dhar and many others all of whom have contributed much to the cause of science in India. During this period my acquaintance with Sir J. C. Bose deepened into friendship and I came to know Lady Bose also who by her exemplary and unsurpassed devotion to her husband and by her charm of manners, which brought them many friends, contributed much to the success of Sir J. C. Bose's scientific campaign in Europe. It was during this trip that Sir J. C. Bose offered me the post of the superintendent of this Institute which was later held by my esteemed friend and colleague, Professor N. C. Nag. It was Sir P. C. Ray and Professor Donnan who advised me to stay on in England a little longer, otherwise, I might have been a close associate of Sir J. C. Bose in the development of the Bose Institute.

While I missed an excellent opportunity of working direct under him, I confess that his wonderful technique of experimental manipulation, his masterly exposition of ideas, his catching enthusiasm and his belief that it is through science only that India will rise industrially made an indelible impression on my mind. It is, therefore, a matter of sincere joy and pride to me that you have deemed fit to honour me by inviting me to this historical lecture theatre where that philosopher scientist, that inspirer of the young and intellectual India, stood and lectured himself".

Private Educational Enterprise

THE National Council of Education, Bengal, was organised by leaders of public thought during the 'Swadeshi' days of 1905. A college and a number of schools all over the country were established in the first flush of enthusiasm and a number of persons bequeathed large sums of money and encouraged the organisers to strive after a re-orientation of the educational policy. Gradually excitement died away and the college being not affiliated with the official University, students could find very little employment. The technical section of the college however continued to serve a long-felt need and has developed into the present College of Engineering and Technology, Bengal, situated at Jadavpur, a few miles away from Calcutta. The College enjoys a very good reputation. The annual report of the Council observes that the departments of mechanical, electrical and chemical engineering need to be supplied with additional apparatus and appliances, and the agricultural classes are in need of development by opening dairy farming and other kindred branches. There are some departments of engineering and technology, such as mining engineering, communication and automobile engineering, sugar and film technology which ought to be added to the curriculum to meet the demands of the time. There has been also a growing demand for admission to the college which cannot be fully met owing to lack of accommodation in practical and theoretical classes. Besides, the existing buildings are in need of repair. The Council in the present state of its finances is unable to meet these various requirements. The Council has, moreover, been hard hit by the economic depression prevailing in the country and its income from the endowed properties and bequests in the shape of shares and debentures has considerably diminished during these years. The total expenses last year amounted to more than Rs. 1½ lakhs. We support the appeal by the Council for contributions from the generous public.

The Deccan Education Society of Poona is another institution which deserves mention in this connection. They are running successfully a number of colleges and high English schools, notable of which is the Fergusson College. The Khalsa Educational Trust is also maintaining a number of colleges and schools in the Punjab and Bombay presidencies.

Control of Lantana Weed

PUBLIC interest has been attracted towards modern scientific ventures in the biological control of noxious weeds. A survey carried out by the Forest Research Institute shows that there are

no indigenous insects that can be used to exterminate lantana weed in India, although some 400 species visit this weed. Investigations with regard to its best control were started as early as 1916 but no suitable insect enemy could be reared in India and the Government was against importing insects from outside. In 1921 the lantana seed-fly (*Ophiomyia lantanae* Fg.) was brought to Mysore from Hawaii but excepting a few flies the breeding attempt was unsuccessful. The flies were not taken care of but in 1932 it was revealed that the flies are present all over India and could be reared out of ripe lantana berries. The presence of these was not detected during the survey and the incidence of these, however small, all over the country is an intriguing matter. A lantana bug which is capable of destroying lantana flowers and shoots in a spectacular manner has recently been established in Australia from Fiji and Hawaii. This bug could do useful work in India, but its introduction should be carefully supervised and conducted in a methodical scientific manner. Beeson and Chatterjee (*Indian Forest Records*, Vol. 6, No. 3, 1940) have re-opened the question whether an all-India policy to control this pest is not due now. They suggest a resurvey of insect fauna of lantana in its original home in Mexico.

Underground Water Supply for Calcutta

CALCUTTA's population of 1,250,000 is at present using some 70,000,000 gallons of filtered water daily, this being the amount pumped from the Hooghly at Palta, some 16 miles north of Fort William, which gives an average of 56 gallons per head daily. But the Hooghly is gradually silting up and there is gradual deterioration and pollution of the river water above the intake. In view of this, Calcutta Corporation recently sought expert opinion about the nature of the underground strata below the Gangetic delta in order to instal a series of deep tube-wells to replace the present arrangement. To supply the present quantity, arrangements will have to be made for pumping just under 3,000,000 gallons per hour for 24 hours daily. At Ahmedabad, where this is the quantity of water pumped hourly from tube-wells, the supply comes from three groups of aquifers between 110 and 180 feet, 280 and 340 feet, and 380 and 460 feet respectively. But the problem at Calcutta is different. Dr A. L. Coulson of the Geological Survey of India has made a preliminary investigation into this problem of underground water supply for Calcutta and the recently published G. S. I. memoir '*The Geology and Underground Water Supply of Calcutta, Bengal*', contains the results of his studies.

The sub-soil water level in Calcutta, as in most parts of the Gangetic delta, is high, being usually 12 to 18 feet below ground level. The average height of Calcutta above sea-level is under 20 feet and so the ground-water level is usually 2 to 4 feet above mean sea-level, according to the season. Potable water has been obtained in some parts of Calcutta and Howrah at depths of less than 200 feet, but it is generally necessary to sink more to obtain good drinking water. There seems to be a general definite decrease in chlorine content as one proceeds away from river Hooghly. But the rate of decrease is less on the Calcutta side of the Hooghly than on the opposite side, where the fall in salinity is very marked within a short distance. This seems to be due to the sub-soil flow of water from the Damodar river.

The strata under Calcutta however cannot be regarded as a single unit from the point of view of water replenishment. Should the ground-water level, by reason of dryness of the season or removal of water by other causes, fall below mean sea-level, then the local rain water will subsequently replenish the upper sub-soil water and bring it again to its natural position a few feet above mean sea-level. But it will not have any considerable effect, if any, on the deeper underground water. The deeper sub-soil water must, in view of its generally slow but definite southerly flow, has an origin distinct from the local rainfall. The deep aquifers under Calcutta, at depths greater than 1,000 feet, where they have been proved to exist, have been estimated to be incompetent to provide the required amount of potable water incessantly.

All supplies of good potable water tapped in Calcutta by the deeper shallow wells and by all medium and deep tube-wells are probably derived by percolation from the Ganges and the Brahmaputra rivers over a hundred miles to the north. The amount of water extracted by tube-wells in Calcutta, Howrah and their vicinity is relatively very small, and natural replenishment now is sufficient to replace all that which is extracted. But if the number of tube-wells in and around Calcutta is increased, there is danger of the water deteriorating for two reasons: firstly, owing to an insufficient amount of water percolating from the above rivers; and secondly, owing to the infiltration of sea water from the Bay of Bengal where formerly the larger natural underground flow was a sufficient barrier to prevent this. The most economical spacing of wells will depend upon the depth to water level, the depth to which the wells are driven, the radius of the circle of influence of the well, and the distance through which the water level is lowered by pumping.

In the opinion of Dr Coulson, an experimental tube-well of a depth of 5,000 feet, or less, according to whether or not the basement rocks underlying the Gangetic alluvium are encountered before that depth, will provide much useful information. It is the coarse gravel beds immediately overlying the basement rocks that will most likely furnish water under artesian conditions, if such actually do exist.

In this connection, a geologist has raised the problem of the possible effect of overpumping on structures standing in the area. The first result of overpumping is desiccation of beds and consequent shrinkage causing cracks and settlements. Some years ago, a very well-known heavy building in London, one of Wren's masterpieces and a monument to his genius, developed small cracks and those went on widening at such an alarming rate that it gave cause for great anxiety to the nation. All possible devices were tried to prevent further damage to the building by the use of bolts, nuts, and tie-rods, but to no purpose. A geologist began to think in a new line. He thought that since percolation of rain-water falling on London was reduced by the gradual paving of streets preventing percolation, the "London Clay", a thick plastic clay underlying London, must have been getting gradually desiccated with a consequent shrinkage of the clay resulting in production of cracks by settling. Engineers bored holes round the building and water was forced into the London Clay under it, and as was expected the cracked faces began to approach and ultimately joined together exactly in their original orientation without the slightest deviation or displacement. But in Calcutta the surface layers being rapidly alternating, this device may not work satisfactorily in the event of similar danger.

Facilities for Practical Training in Great Britain

THE High Commissioner's office reports that as a result of the efforts by the education department in collaboration with the India Store Department, 143 candidates were provided with practical training facilities in the various branches of engineering and technology, during the year 1938-1939. The secretary of the department points out that during the past few years the difficulty of obtaining suitable and satisfactory training facilities for Indian students has markedly increased, especially in industry generally as distinct from the various branches of engineering. It has been practically impossible to obtain facilities in certain industries where secret or special processes were involved, such as the chemical and glass industries, or where, as in textiles, Indian competition is formidable. He goes on to say that the main difficulty most probably arises, not from

any racial discrimination, as is sometimes alleged, but from the threat of intense trade competition. The instinct of self-preservation, accounts for the natural reluctance to accept trainees, who may turn out to be potential competitors. It has been pointed out that the firms have not, in the majority of cases, any inducement, financial or commercial, to encourage or recompense them for the trouble to which the management and staff are put, or for the disturbance of their organisation which the presence of trainees inevitably involves. But cases may be found out where premium was forthcoming to compensate the dislocation but other grounds were quickly found out for refusing such applications. Moreover, we believe that the special tariff facilities enjoyed by the British goods should serve as sufficient financial and commercial gain for providing these facilities. But unfortunately the State intervention stops short at this point and while commercial treaties with other countries include a clause for training, our government possibly considers such insistence in relation to Great Britain not essential for the welfare of the country.

In our review of the Progress of Broadcasting in India published in the last November issue of this journal we pointed out on p. 254 the desirability of sending students to B. B. C. for technical training. The present Report recalls that in the Report for 1934-35 there were particulars of a scheme under which the Director-General of the British Broadcasting Corporation kindly arranged to accept annually two Indian students, from amongst those who had graduated in electrical engineering from English universities, for a two years' apprenticeship course in broadcasting engineering alongside of the home apprentices whom the Corporation train and select for their own engineering branches. It was rightly hoped that the development of broadcasting in India would be materially assisted by this training scheme which in due course might be expected to provide a supply of well-qualified Indian engineers. The Report informs us that none of the four students who duly and satisfactorily completed the course and thus qualified as fully trained wireless broadcasting engineers was able to find such employment when he returned to India. In these circumstances, and after consultation with the British Broadcasting Corporation and the Government of India the scheme has been abandoned.

It is strange that though the A.I.R. was constituted as a State department in 1932, (two years before the scheme) the arrangements for the technical training have since been abandoned. We are in the dark about the circumstances under which the Government of India agreed to do away with the prospects of qualified engineers. Arrangements are however in

force at present for training young men in the programme side who later work as directors of stations. We would request the authorities of the A.I.R. to enlighten the public about this situation.

Veterinary Research in India

THE Imperial Veterinary Research Institute at Mukteswar, in the Kumaon District of the United Provinces, has completed its fiftieth year. The nucleus for this was the central research laboratory for veterinary science recommended by a committee set up in 1885. That was the first government research laboratory in this country. On December 9, 1889, the foundation stone of the proposed central research laboratory was laid on a site near the College of Science in Poona. The laboratory was opened towards the end of 1890, under the charge of Dr Alfred Lingard, and the first undertaking was the making of Pasteur's anthrax vaccine. His work on surra and Dr Edward's introduction of goat virus vaccine for rinderpest stand as monumental achievements of the Institute.

Anthrax became of secondary importance compared with rinderpest, and as the climate of Poona had been found unsuitable for work on certain bacteria, the laboratory was moved in 1893 to its new home, in the Kumaon Hills of the United Provinces. In 1897 the laboratory was visited by the noted German bacteriologists Koch and Pfeiffer, on whose advice the preparation of anti-rinderpest serum was commenced.

The present main activities of the Institute are research and the production of vaccines and sera. Since the first anti-rinderpest serum was issued in 1899, the demand for these biological products has increased steadily, and growing scientific knowledge has widened the Institute's activities. In 1913 lands were acquired for a sub-station at Izatnagar, on the plains, 85 miles from Mukteswar, which has enabled the production side of the Institute to be separated from research, and a number of new research sections have been added. The latest additions are the Animal Nutrition and Poultry Research sections which were opened by His Excellency Lord Linlithgow in 1939.

The Imperial Veterinary Research Institute can claim to be one of the largest veterinary research institutions in the world. The Institute has been engaged in the study of problems peculiar to Indian conditions and the progress has been satisfactory. But adequate measures are still to be taken to demonstrate the beneficial results of scientific management of livestock to the villagers under their conditions of living. There is an attitude of suspicion amongst the village folk besides their chronic poverty which

stands in the way of utilising the results of research for improving the cattle and preventing epidemics.

Science Congress at Benares

INDIAN Science Congress Association holds their 28th session at Benares at the invitation of Benares Hindu University from January 2 to January 8, 1941. This year the Association has chosen one outside the research laboratories to guide their deliberations. This election has happily coincided with the need of the moment, namely the organisation and development of industries in India. This is however not the first occasion when a non-scientist has been elected general president. The late Sir Rajendra Nath Mookerjee presided over the Calcutta session of the Congress in 1921. Sir Ardeslir Dalal's association with the Tatas, the largest industrial group of the country and other industrial combines is expected to pave the way for a much closer relation of the scientists with the industrialists. Growth of industries and their development are essentially dependent on scientific discoveries. There was a time when the progress of industries was very slow and the mammoth factories for mass production at the beginning of the industrial era required the working out of a few simple basic principles. But now specialisation has revolutionised the industrial activities and, to make matters more complex, newer processes are replacing the old and newer industries are springing up. The tempo of this march has increased within recent times and it is essential that scientific talents of the country should not be left aloof in the academic laboratories. It will be of little assistance to simply borrow scientific help by importing scientific experts who have very little knowledge of the conditions of the country. It is time that science formed an essential element in the industrial life of India and the factories maintained adequate research staffs for their day-to-day problems and for long-range research projects. Some of the agricultural industries, cotton, jute and sugar have established research institutions but there are problems which require a vaster organisation and a wider vision and a larger team. The full responsibilities should not always be laid at the doors of the Government but the industrial entrepreneurs have a large share to bear in this respect. We still need more propaganda and public education so that the ordinary citizen ceases paying homage to science and scientists as objects of reverence and curiosity.

Programme of the Congress

THERE are this year 14 sections including the new section on engineering where Mr C. C. Inglis will address on 'Hydrodynamic Models as an aid to

Engineering Skill'. In the mathematics and statistics section Prof. M. R. Siddiqi will address on 'Functional Analysis and Mathematical Physics', in the physics section Prof. P. N. Ghosh on 'Role of Applied Physics in Industry', in the chemistry section Prof. Mata Prasad on 'Physico-chemical Studies of Gels', in the geology section Dr M. R. Sahni on 'Palaeogeographical Revolutions in the Indo-Burmese Region and Neighbouring Lands', in the geography and geodesy section Dr S. M. Tahir Rizvi on 'Conservation of India's Natural Resources', in the botany section Dr Shri Ranjan on 'Respiration of Plants in Light', in the zoology section Prof. A. Subba Rao on 'Some Aspects of Mammalian Placenta', in the entomology section Rao Bahadur Y. Ramchandra Rao on 'Some Observations on the Periodicity of Locust Invasions in India', in the anthropology section Mr Tarak Chandra Das on 'Anthropology in the Service of the Individual and the Nation', in the medical and veterinary research section Dr A. C. Ukil on 'Some Aspects of Public Health in India', in the agriculture section Mr K. Ramiah on 'Plant Breeding and Genetical Work in India', in the physiology section Dr B. B. Dikshit on 'Some Observations on Sleep', in the psychology and educational science section Dr I. Latif on 'Psychology and the Future of Mankind'.

Amongst the discussions, interesting subjects like 'Environment and the Distribution of Population in India' (section of geography and geodesy), 'Salt from the Fast Lake Bitterns Area' (section of chemistry), 'Need for the Exploration of Wild Forms for the Improvement of Crops' (section of agriculture and botany); 'Reasons for the lag in India of utilization of medical knowledge by the individual and initial steps towards solving the problem' (section of medical and veterinary research) have been arranged. The section of botany will hold a discussion on 'The curricula for B.Sc. (Hons.) examination in the various Indian universities; their adequacy or otherwise for fitting graduates to undertake research work'. The series of popular lectures arranged this year appears to be stimulating to the laymen. Dr Cyril S. Fox will speak on 'Some Aspects of the development of India's Mineral Resources'; Prof. K. S. Krishnan on 'The Earth as a Giant Magnet'; Prof. J. N. Mukherjee on 'The Soil and its Conservation' and Dr S. S. Bhatnagar on 'Some New Applications of Colloidal Chemistry'.

As in previous years the Indian Statistical Conference will proceed with its work in close co-operation with the Indian Science Congress; and joint meetings have been arranged with four sections of the Congress. The subjects are "Correlational Analysis of Anthropometric Material", "Growth Studies with special reference to Nutrition and Public Health", and "Standard Yields of Crops".

Announcements

Dr B. N. Singh of Patna Science College has been elected a member of the Institute of Radio Engineers of U. S. A.

The Council of Calcutta Mathematical Society has decided to award the Krishna Kumari-Ganesh Prasad prize and gold medal for 1943 to the author of the best thesis on "Conception and development on the theory of numbers by Indian mathematicians before 1600 A.D." The last date of submitting the thesis for the award is 31st March, 1943. The prize

and the medal shall be open to competition to all nationals of the world without any distinction of race, caste or creed. Full details can be obtained from the Honorary Secretary, Calcutta Mathematical Society, 92, Upper Circular Road, Calcutta.

PROFESSOR F. R. Bharucha of Royal Institute of Science, Bombay informs that the inaugural meeting of the Indian Ecological Society will be held on Tuesday, 7th January, 1941 at Benares to discuss the constitution of the Society, its programme and to elect office-bearers.

CYCLOTRONS IN USE IN DIFFERENT PARTS OF THE WORLD

Readers of this journal are familiar with the story of invention and use of the cyclotron. On account of its unrivalled efficiency in producing high energy particles, which are used for smashing the nuclei of atoms and for the manufacture of artificially radioactive elements which are now used as tracers in biological researches, the cyclotron has been installed in many leading physical laboratories of the world. The place of pride has been taken by the United States, and in U. S. A., by the Radiation Laboratory of the University of California, where it was originally invented by Prof. E. O. Lawrence in 1932. The following gives a list of cyclotrons in use in different laboratories with their characteristics.

It has now been fashionable to designate a cyclotron by the weight in tons of the amount of iron and copper used. The first cyclotron probably did not weigh more than a ton. The latest cyclotron which is being constructed by Lawrence will require about 4500 tons of iron and 400 tons of copper.

<i>Year of construction</i>	<i>Weight in tons</i>	<i>Pole-piece size</i>	<i>Maximum energy in MeV's</i>	<i>Projectile</i>
<i>Radiation Laboratory, University of California—</i>				
1932	1 (approx.)	11"	1.2	(Proton)
1934 ... ..	...	27.5"	5	(deuteron)
1939 ... ..	...	37"	8	"
1940	250	60"	25	"
1941	5000	184"	100 (approx.)	"
Chicago, 1940	66	32.5"	6.5	"
Princeton, 1938	40	27.5"	9	(α -particle)
Purdue University, La Fayette, Indiana, 1939 ... ..	...	...	8	(deuteron)
Biochemical Research Foundation, Franklin Institute, Philadelphia, 1939 ... ..	...	37"	11	"
Harvard University, Cambridge, Mass., 1941 ... ..	...	37"	...	...
Cambridge, England ... ..	...	42"	8.6	(deuteron)

Besides these, of which we have definite information, cyclotrons have been or are being installed at the following places.

America:—Ann Arbor, Michigan; Cornell University, Ithaca, New York State; Columbia University, New York City; Rochester, N. Y.; Bartol Research Institute, Swarthmore; Urbana, Illinois; Columbus, Ohio; McGill University, Montreal, Canada; Yale University, New Haven, Connecticut; Seattle, Washington; Blumington, Indiana; Chemistry Department of the University of California (16").

Great Britain:—Universities of Liverpool and Birmingham.

Denmark:—Institute for Theoretical Physics, Copenhagen.

Russia:—Institute for Physics, Leningrad.

France:—College de France, Paris, France.

Sweden:—University of Stockholm, Sweden.

Japan:—Nishina Institute, Imperial College of Science and Technology, Tokyo.

SCIENCE IN INDUSTRY

Effect of Factory Conditions on Output

PHYSICAL, medical and psychological investigations into some factory problems have disclosed a number of interesting points which should be noted in building up an efficient and successful manufacturing plant. The basic reasons for industrial failure are bad factory conditions, ill health of the employees, lack of personal relationship and social forces. About 10% of accidents, and diseases arise from factory conditions which include noise-level, light, dietary, social relations and emotional adjustments. About 5% of industrial accidents are caused by poor light condition in the workshop and factory, which is usually found to be about half of what is necessary. Poor light and high noise-level is a cause of strain and fatigue to the nerve, and they lower the output. Heat and high humidity of the air produce fatigue to a very high degree; the effect is very much remarkable in warm countries. Even in moderate climate of England the steel workers produce 12% less in summer than in winter. The optimum temperature in a factory in the Western countries has been suggested as 65-70°F.

When a job is reduced to such stark efficiency that only small group of muscles are used, they quickly become fatigued, apparently because they cannot force the heart to increase output. A mobile job is less fatiguing. Aptitude and liking of one's own job is also an important thing for output.

Merely increasing working hours does not increase output proportionately. The general trend of output with time of work has also been studied. Output curve gets off to a slow start, climbs to a peak, falls off about the middle of the spell, rises again, then drops as the quitting time draws near. In heavy work a true fatigue-drop of about 14% can be detected towards the end of the spell, but the drop during the middle of the spell in majority of cases, is caused by boredom.

K. R.

Noiseless Steel Cutting

OXY-ACETYLENE flame-jet which has a temperature of about 2500°C, is now being used for cutting

steel plates quickly, efficiently and noiselessly. This not only increases the efficiency of steel cutting alone but the process increases the efficiency of the factory as a whole, owing to the elimination of noise which produces nervous fatigue of the workmen.

K. R.

Increasing the Utility of Jute

JUTE is now being made into soles of slippers in Argentine according to the *Jute Review* of August, 1940. The jute-soled slipper is known there as *alparagala* and is in use for a long time. The soles are light, do not slip on wet wood or grass, and can be dried without serious hurt to the sole. They prove useful in sport and in sea-bathing. The slippers however lack in quality and style and therefore when the upper is fashionably designed, this novelty is likely to prove a commercial success.

The same journal informs that a British patent has been granted to a process to open up roots of jute to make them usable as ordinary jute fibre and to improve the jute fibre or yarn by giving it the character and similar qualities as wool and wool yarn. Jute roots are bathed in sodium hydroxide solution and cooking salt and then the liquid is pressed out and the roots washed out in clean water. They are then put into water mixed with a small quantity of sulphuric acid. The material is then passed through a softener where the water is pressed out and the roots soften. After rinsing in clean water which is pressed out, the material is dried.

In the case of the jute fibre or yarn or other vegetable fibres such as flax, hemp and sisal, the same process as above is followed with further chemical treatment, which 'woollenises' the fibre. After sulphuric acid bath the material is rinsed in clear water which is pumped out and then bathed in a mixture of chloride of lime and ammonium bicarbonate. After final rinsing with water the water is pressed out and the material dried.

Preservation of Fruits by Wax

THE preservation technique has been much improved with the advent of electrical refrigeration which maintaining a low temperature guards against bacterial growth and enzyme decay. Besides these two destructive agents, humidity is another factor when water-loss of the vegetables and fruits is taken into consideration. Evaporation leads to shrinkage of the fruits. Recently it has been found that fruits, especially citrus fruits such as lemon, orange etc., when coated with a very thin film of natural or artificial wax does not shrink due to evaporation of water. The fruits are first washed and then, without drying, momentarily dipped into a cold bath of wax emulsion in water at room temperature. The composition of the emulsion however is rather complex, but essentially it contains colloidal suspension of one or several kinds of waxes in water with a small proportion of dissolved soap to keep the wax particles in dispersed phase. The coating is in fact very thin, only a few microns (10^{-4} cm) in thickness. Lemon, orange, cucumber etc., are very suitable for such treatment, but leafy vegetables are not so.

K. R.

Substitutes for Diesel Fuel

THE Industrial Research Bureau's recent bulletin entitled "Indian Vegetable Oils as Fuels for Diesel Engines" records the results of three years' investigations into the subject made at the Government Test House, Alipore, Calcutta. It is reported that groundnut oil, cottonseed oil and rapeseed oil can be used satisfactorily as diesel engine fuel in place of mineral diesel oil. For this substitution, hardly any alterations are necessary to the ordinary diesel engines.

The behaviour of a number of other oils, including castor, coconut, til, mohua, kapok, karanj, punnal or undi and polang, has also been investigated. The vegetable oils are generally more expensive than the cheaper mineral oil. But in certain parts of the country where mineral oil is more expensive, the locally produced vegetable oils will prove comparatively cheap and economical. The present investigations indicate one way in which the oils

can be utilized in this country, which is one of the largest producers of vegetable oils in the world.

It was found that the power reduction of the engine when using these vegetable oils amounted to not more than 2 to 3 per cent. This is significant in view of the much lower calorific value of the vegetable oils, as it indicates that the heat efficiency of vegetable oils is definitely higher than that of mineral oils when used in this way.

Manufacture of Shellac Moulding Powders

RECENT investigations at the Indian Lac Research Institute at Namkum, near Ranchi, have shown that shellac composition powders that could be used for the manufacture of moulded goods like switches, etc., could now be prepared by mixing the ingredients between hot-rollers without using alcohol, thus saving in cost and increasing the ease of working.

Up to now the preparation of the composition powders was done by what is known as "wet-process" in which shellac, fillers and chemicals were mixed in a medium of rectified or methylated spirit, followed by the recovery of the solvent.

In the present method it has been found that after the shellac-formal is produced by heating shellac and formalin for an hour and half, the subsequent interaction of urea with the formal is too rapid unless carried out in an alcoholic solution. Attempts to incorporate urea with the shellac-formal between steam-heated mixing rollers led to premature curing of the composition into a rubbery mass before it became homogeneous. By adding however small quantities of a high-boiling solvent like cyclohexanol or a suitable plasticiser, this difficulty has been obviated, as the plasticity of the composition under heat is considerably increased, thereby allowing sufficient time for the reaction. Cyclohexanol in the above experiment can be replaced by Santiciser 8 (mixture of ethyl and methyl para-toluene sulphonamides) with similar results.

It must be noted however that the best results as regards uniform surface gloss are still being obtained by the "wet process", but the distinct economy in the cost of production might induce manufacturers to prefer this dry-mixing process.

Nylon

P. B. SARKAR

Chief Chemist,
Indian Central Jute Committee, Calcutta

On the 27th October, 1938, while speaking to an audience attending the *Herald Tribune* Forum, in New York, Dr C. M. A. Stine, Vice-President of E. I. du Pont de Nemours & Co. made the first public announcement that the chemists of his Company had succeeded in producing from coal, air and water a new textile fibre strikingly resembling natural silk. This has now passed the experimental stage and has already appeared in the market. It is the first man-made organic textile fibre from coal, air and water—synthetic in the true sense of the term and made from sources other than animal or living plant.

The du Pont de Nemours & Co. is one of the biggest industrial concerns of the United States and of the whole world too. An idea of how big it is may be made from the fact that in its 138th year ending on Dec. 31, 1939, it had a net income of 93,218,664 dollars. During this year it paid as wages and salaries a sum of 97,600,000 dollars and spent about 27,700,000 dollars in plant construction. A huge sum had been set apart every year by this Company for planned research on synthetic organic chemistry to find out a suitable textile fibre—and for long ten years the du Pont chemists worked assiduously on the problem. The result is the silk-like fibre which they call 'Nylon'. This reminds us of the synthesis of indigo by the German chemist Adolf von Baeyer and his co-workers who took 20 years to finish the job; the famous German Firm—the Badische Anilin und Soda Fabrik—spent £2,000,000 on chemical research and technical development before synthetic indigo was placed on the market. We all know what it meant for the world's biggest natural indigo trade of India. Who knows what will happen to the natural silk industry of the world in the coming few years?

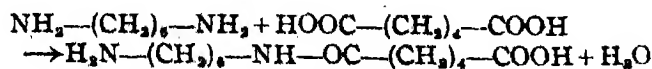
Nylon is a fancy name arbitrarily chosen. The names of the most important industrial fibres—cotton and rayon (artificial silk)—end in 'on'. So the word has been coined with this similarity in view. Another synthetic fibre made from polyvinyl acetal resin has similarly been named vinyon. This recalls the names of metals, which usually end in 'um'.

Natural fibres, e.g., cotton, silk, wool etc., are composed of giant molecules—molecules that are many thousand times heavier than the hydrogen molecule. Simple glucose molecules are the building stones of cotton cellulose—these join together in large numbers by a process known as polymerisation, until very long chains are formed; fibrous structure then appears and we have cellulose. On the other hand, if cellulose fibre is partially degraded—say by treatment with mineral acids, the molecular weight rapidly falls and it is converted into a powder. In producing a synthetic fibre these two essential facts are to be kept in view—the molecules formed must be extraordinarily large and also, the structural units should be arranged length-wise. A cyclic molecule however big is of no use; it never forms fibres.

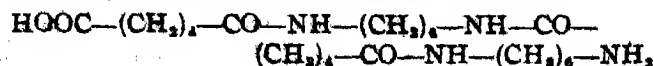
HOW NYLON IS MADE

As has already been mentioned, the basic materials for the manufacture of nylon are coal, air and water. But the actual ingredients are (i) an acid—adipic acid, $\text{HOOC}-(\text{CH}_2)_4-\text{COOH}$, made from coal-tar benzene and (ii) an amine—hexamethylene diamine, $\text{NH}_2-(\text{CH}_2)_6-\text{NH}_2$, obtained from coal-tar hydrocarbons and ammonia. Ammonia is derived from the nitrogen of air and hydrogen of water by the well-known Haber process.

The acid and the diamine are condensed together in presence of an inert diluent of high boiling point, e.g., mixed xylenols, cresols etc. by heating for a few hours at about 200°C . High molecular poly-amino-methylene carbonyl compounds are thus formed:

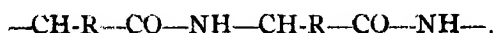


The condensation product again reacts with one molecule of acid and one molecule of amine to form:



which in its turn combines with a third molecule of acid and a third molecule of amine. And this goes on until the molecules assume gigantic size and show fibre-forming properties. The water is removed as soon as it is formed and the solvent recovered by distillation under reduced pressure. The operation is carried out in an inert atmosphere of nitrogen to avoid slight decomposition and consequent darkening of the thread. As the viscosity of the mass increases due to higher degree of polymerisation, its electrical conductivity diminishes and is measured continuously. The operation is complete when the intrinsic viscosity of the mass is above 0.4. The final product consists of a mixture of long and short chains and homologous polymers. The molecular weights of these polymers—'super-polyamides' as they are called—vary between 7,000 to 20,000.

On cooling, the reaction product sets to a hard stable solid, but on extruding the molten material at 270°–80°C by means of a pressure head of nitrogen through fine orifices filaments are obtained. The filaments at this stage are rather weak. These are then stretched by a process called 'cold-drawing' whereby the threads not only become finer but also increase in strength and pliability from 200 to 700 times, and are permanently extended. The cold-drawing is an essential step in nylon manufacture—this is responsible for its out-standing fibre structure. The process may be said to have oriented the molecules along the axis of the fibre producing great strength and pliability. The mechanism of the formation of super polyamides of nylon, it may be pointed out, is analogous to that of polypeptides from amino carboxylic acids as effected by Emil Fischer—the wizard of organic chemistry. The structural units of polypeptides are:



PROPERTIES OF NYLON

Rayon is either regenerated cellulose or cellulose acetate and contains no nitrogen. Between rayon and silk there is only a physical resemblance. But nylon resembles silk both physically and chemically—nylon contains nitrogen and has a more or less protein-like structure. Nylon filaments can be spun to very fine deniers, *e.g.*, 0.2 denier—these are characterised by high tensile strength—both wet and dry—and exceptional elastic recovery properties. In fact, nylon threads are finer in structure, more elastic and much stronger than silk threads. The following table

shows its tensile strength in comparison with cotton and silk:

TENSILE STRENGTH AT BREAK

	g. per denier	kg. per mm ²
Cotton	... 2	28
Silk	... 4	35
Nylon	... 5.2 (dry)	50
"	... 4.4 (wet)	—

Tensile strength of nylon remains unchanged at ironing temperatures up to 205°C, melting point of nylon being 245°C or near about this.

Nylon threads are lustrous and silky—their X-ray diffraction photographs are of the crystalline powder pattern. They exhibit a remarkably high double refraction—of the same order as natural silk or cellulose fibres:

	Nylon	Silk	Ramie
(n _D) _D	... 1.580	1.584	1.599
(n _D) _A	... 1.520	1.529	1.532
Double refraction	... 0.060	0.057	0.067

Nylon possesses high resistance to moisture and does not mildew. Moisture regains by nylon fibre at relative humidity 60 and 90 are 3.70% and 6.70% respectively. Ordinary bleaching agents, *e.g.*, 3% sodium hypochlorite or 3% hydrogen peroxide, do not affect the fibre when kept in the bath for more than two hours. None of the common solvents can dissolve nylon. Chemical reagents in general and hot alkalies and soap-liquors in particular, have little action on nylon. Nylon fibres are readily coloured and can be dyed with any dye—acid, mordant, direct cotton, acetate rayon, vat and soledon dyes—each type making its particular contribution to the range of shades and fastness properties.

By a simple ignition test, rayon can be distinguished from natural silk by the layman but not so easily nylon from silk; both burn with difficulty and leave a bead-like residue. Hot caustic alkalies dissolve silk but not nylon, and phenol dissolves nylon readily but not silk, wool, cotton and viscose rayon. Acetate rayon however, dissolves in phenol but it is also soluble in acetone in which nylon is insoluble. Thus, one can distinguish nylon from other textile fibres.

MANUFACTURE OF NYLON

Four patents for hosiery and other knitted fabrics made of nylon were issued on May 9, 1939 to E. I. du Pont de Nemours & Co., Inc. Wilmington, Del.

by the U. S. Patent office. To bring nylon into general commercial production as early as possible the Company has invested 2,500,000 dollars in plant extension at Belle, W. Va., for making nylon intermediates and 8,500,000 dollars on the erection of a nylon textile plant at Seaford, Del. Production however proceeded to the extent permitted by a single pilot plant operated near Wilmington, Del., and hosiery made of nylon yarn was placed on sale on October 24, 1939, for the first time. The first unit of commercial yarn plant at Seaford, went into production on December 16, 1939. The capacity in full operation is expected to be 4,000,000 lbs. of yarn per year. It is estimated that during 1940 about 5,000,000 pairs of nylon hose will be released at about 1.15 dollar per pair. The present output of nylon by the du Pont factory is sufficient to supply 10% of the silk stocking market in U. S. A.

The Imperial Chemical Industries and Courtaulds, Ltd., have recently combined to exploit du Pont's nylon in Great Britain. Nylon produced by that joint Company will, in due course, be supplied to the existing silk manufacturers and other textile industries. The first tooth brushes made of nylon fibre by du Pont have appeared on the British market on June 21, 1940. We, in India, may expect nylon products shortly, if they are not already in the market.

On the advent of nylon, the silk industry of the world will be seriously affected. The price of nylon is now at par with that of silk; as is usual with synthetic products, with time, the price will go down and the quality will go up. Japan has built up in course of the last two decades the world's largest rayon industry. In fact, she has gained her lost silk

market by rayon. Japan's silk industry is even now quite big. The nylon issue has already been discussed by the Imperial Diet and with Government subsidy research for finding out a nylon-like product has begun. It is reported that the efforts have largely been successful. "Japan's synthetic No. 1" made from vinyl acetate is said to be similar to nylon. It may be mentioned here that the American Viscose Co. is reported to have produced a synthetic fibre called 'Vinyon', from vinyl chloride and acetate and I. G. Farbenindustrie's (of Germany) Pe-Ce (Polyvinyl Chloride) is also a similar product. All these are derived from coal ultimately. There are sufficient coal, air and water in India. There is no reason why a nylon-like product should not be made in this country as well.

USES OF NYLON

The high tensile strength coupled with its wear resistance renders nylon valuable for hosiery. Next come other knitted goods, lingerie, bathing costumes, sewing threads, woven materials, shirtings, pyjamas, and woven mixtures with other textile fibres to increase their strength and wear resistance or impart the possibility of fancy weaves and coloured effects.

Nylon has already been on the market in the form of bristles for brushes, gut for fishing leaders and surgical sutures, and yarn for sewing thread and fish lines. The yarn may also be used for laces. Nylon brushes are a great aid in bottle washing. Bead cord made of nylon is being supplied to the jewellery trade. Nylon threads are expected to be used by R. A. F. for parachute fabric, balloon silk, and air-craft construction. 'Exton' used for tooth brush bristles is merely a trade name for nylon bristles.

MEDICINE & PUBLIC HEALTH

Sulphathiazole in Malaria

PAKENHAM-WALSH *et al* (*Lancet*, 2, 79, 1938) observed that prontosil red, prosectasine and sulphapyridine have antimalarial properties. Each of these compounds contains the group :N.C₆H₄.SO₂.NH. Since sulphathiazole also contains the above group, Pakenham-Walsh *et al* (*Lancet*, 2, 485, 1940) studied its antimalarial activity in patients suffering from general paralysis of the insane, who were injected with benign tertian malarial parasites. They observed that the compound reduced the parasite count and completely eliminated them from the blood stream. The dose of sulphathiazole required was higher than the other sulphonamides used for the purpose. This is due to the relatively rapid excretion of sulphathiazole (*Lancet*, 1, 883, 1940).

S. B.

Calcium Therapy in Heart Failure

INTRAVENOUS injection of calcium gluconate is given in cases of heart failure. Cheinisse (*Pr. med.*, 30, 81, 1922) observed that calcium enhanced the action of digitalis in patients with cardiac oedema. Bower *et al* (*Jour. Amer. Med. Ass.*, 106, 1151, 1936), however, observed that two of their patients who were fully digitalised died within a few minutes after they received intravenous injections of calcium salts. Rogen (*Lancet*, 2, 452, 1940) has studied the effect of calcium salts in cases of heart failure. He has concluded that intravenous injection of 10 c.c. of 10 per cent. calcium gluconate does not lead to toxic manifestations provided at least two minutes are allowed for the administration. According to him it is dangerous to give intravenous injection of calcium gluconate to digitalised patients. The injection however may be given after the administration of digitalis is stopped for four days.

S. B.

Sulphathiazole in Pneumonia

GAISFORD *et al* (*Lancet*, 2, 451, 1940) studied the effect of sulphathiazole in ten cases of pneumococcal

lobar pneumonia. They have observed that the drug is as useful as sulphapyridine which is mostly used in the treatment of pneumonia. The temperature of the patients, however, does not fall promptly as with sulphapyridine. One chief point in favour of sulphathiazole is that it does not cause vomiting. If sulphathiazole is used in combination with sulphapyridine in the treatment of pneumonia, the most troublesome complication of vomiting can be obviated entirely.

S. B.

Further Medical Supplies

FURTHER to a note on the subject of medical stores supply in the last November issue of this journal (p. 559), we understand that attempts are being made by the Medical Stores Supplies Committee to produce a complex chlorine compound hitherto imported which is essential for the manufacture of many non-irritating efficient disinfectants which are now so largely used. A dye called acriflavine is also an important disinfectant, particularly in war time, and its manufacture in India from locally produced materials is under investigation. Samples have already been produced in an Indian laboratory.

India's most concentrated form of vitamin C is "amla". Amla berries are collected in the Nilgris under the supervision of the Director, Nutrition Laboratories, Coonoor, dried and made into tablets of suitable size for treatment of scurvy.

Substitutes for corks are also being considered. These have become expensive and difficult to obtain owing to the war. Samples of wooden corks made by the Forest Research Institute, Dehra Dun, having two circular slots to increase resilience are being examined and are to be tried out on a large scale. Bottles with threaded glass necks and metal caps as well as bottles with crown corks are also considered as possible substitutes for bottles with corks.

Assuring Long Life to the Old

EXPECTATION of life has gradually increased in countries where conditions of living have been

improved by utilising scientific discoveries. Newer nutritional researches may help in adding another 10 per cent. to the present average age at death. In the United States just after Revolutionary War the expectation of life at birth was 30 to 35 years, in 1900, 50 years, and today white male babies can look forward to 60 and female to 63 years. Though the average longevity has increased, persons surviving to advanced ages are not found to live longer than formerly. Declining birth rate and declining mortality rates for infancy, childhood, adolescence, and early adult life co-operate to yield an aging population. In India however men belonging to post reproductive phase of living, that is past 50, constitute less than 10 per cent. The number of elderly people (past 64) in the States is gradually increasing and an article in the *Scientific American* draws attention to a new branch of medical science, Geriatrics, as opposed to pediatrics, which is developing to help oldsters towards maximum longevity. The elderly have practically all the diseases of youth but none additional and therefore the geriatrician should be specially expert along specific lines. In advanced years the old diseases run a course markedly different from that followed in earlier decades. The organs and their functions change a great deal which in younger patients are traceable to pathological causes. The geriatrician must however regard these as normal or physiological. Treatment of the old has accordingly become a specialized work. In them mild symptoms may lead to fatality. Their reaction to drug is greatly altered. Long stays in the bed for the old may make insidious attack on hearts. On the other hand, the aged endure surgery better than many youngsters.

As regards nourishment the vitamin B-complex is important to the geriatrician to make good the deficiency of his patients. Fat should be less eaten. This medical speciality, geriatrics, is still in an apparently discouraging field, and may be eclipsed if the secrets of rejuvenation are found out, for which the basic bio-sciences have not slackened their research.

First Aid for Burns

THE fundamental principle of first aid for any injury is to avoid further damage to it between the time of the accident and the beginning of medical care. As regards burns, 80 per cent. of deaths from burns are due to shock and collapse. The first aid worker should therefore adopt measures to minimise this danger. Shocks are generally caused in case of burns by loss of body fluids and loss of blood plasma, extreme pain and by toxin absorption. Besides keeping the body and the burned area warm and giving some fluid to the patient, the standard first aid is now an aqueous jelly containing 5 per cent. tannic acid and .5 per cent. phenol. Tannic acid treatment of serious burns resulted from a search for a coagulant of proteins. The Chinese were reported to treat burns with a strong decoction of tea and Dr Davidson who was carrying on the work replaced the phosphotungstic acid on which he had worked so long with tannic acid. Later the technique has been improved and tannic acid jelly has been developed, which including its coagulum being water-soluble can be removed without discomfort. Oils and greases must not be employed particularly in case of severe burns.

Some Essential Health Unit Procedures*

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IF all expectations are realized, those of you who are students for the D.P.H. qualification will be responsible medical officers of health in the near future, some of municipalities, some of districts and some of provinces. In any one of these capacities you will have the duty of setting up or of maintaining a health organization of one sort or another in accordance with the needs of your position.

In your studies at the Institute you have learned of the types of health organizations which are in force in India and throughout the world. The purpose of this talk is to add to your general

* A lecture delivered April 7, 1940 to the D.P.H. students of the All-India Institute of Hygiene and Public Health, Calcutta, at the Singur Health Unit Office, Hooghly District, Bengal.

knowledge by describing to you some essential details of one type of organization commonly designated in India as the health unit system.

HISTORY

The term "health unit" has been introduced from the West and is not particularly well chosen for this part of the world. The question is open now to all of you, as it has been open for many years, to suggest a more suitable name. A title is required which would fit better into the language, history, and habits of the people of India.

In the United States health unit work is referred to as a "county health organization" since the county is the smallest fiscal unit and contains a suitable health unit population. The first county health organization was started in 1909. Thirty years later, 1,370 countries, about one-half of those composing the forty-eight states, had full time directors to supervise the public health interests of the rural population. Since 1910 this type of organization has sprung up in all parts of the world, Europe, South America, Africa, Asia including the Philippines, Malaya, Burma, Ceylon, and India.

In this immediate section the first unit was started in Ceylon in 1926. At the present time there are eleven units in operation in that country. In 1929 a health unit was started in Burma. In India the first health unit began to function in Travancore in May 1931 followed by Partabgarh in the United Provinces in July of the next year. There are now seven health units in India located in the political divisions of Travancore, Mysore, Madras, Bengal, United Provinces, Delhi, and Bombay. Proposals come to our office regularly, and in the last five years an average of one new organization has been added each year. There are proposals now for 1941 and inquiries in respect to years to come. These statements indicate to you that health unit work is not a new activity and that its methods of operation are becoming well known and appreciated in India.

The following points have been agreed upon: The area should have 40,000 people; the budget should be Rs. 30,000/-; the staff should consist of one medical officer of health, one medical officer who, if the purdah system prevails, should be a woman, four sanitary inspectors, four health visitors, who should be trained public health nurses, eight midwives, one clerk and the necessary menials,

There should be adequate funds for travel by the staff and for equipment and supplies. The staff must be specially trained to enable them to undertake all recognized public health activities such as health education, general sanitation, collection and study of vital and morbidity statistics, control of preventable endemic and epidemic diseases, vaccination and preventive inoculation, maternity and infant welfare, school health work, adult hygiene. If this work is faithfully carried out the state or province will derive noteworthy benefits.

In spite of the fact that these procedures have been clearly stated in print and have been generally practised there has been a tendency in many quarters to modify the routine to meet preconceived notions, and frequently such modifications are not in harmony with health unit ideas. Therefore the purpose of this talk is not to describe in detail the setting up of a health unit organization as such information can be had from printed sources but to stress certain procedures which should not be modified and which are essential to success. It is a well-known fact that an organization is only a guide. It will not work of itself. It must be attended to, nourished, encouraged, just as a farmer takes care of his crop from the time he stirs the soil until the harvest. It is such points as these which will now be discussed.

SURVEYS

First consideration will be given to the survey. When a responsible officer expects to undertake a programme of work his first plan should be to see and study the field of operation in order to find out the nature of the problem which awaits him. If he is wise he tours the area, meets the people, questions them, observes details, and takes all other steps which will enable him to get accurate knowledge of the section and of its people and of its problems. Based on his own observations and on the information gained from the people he can come to a rational conclusion in respect to the procedure which it will be necessary for him to follow in order to deal with the situation he has encountered. This long statement is a definition of what is meant by a survey.

One must know when and where and under what conditions events which lead to illness and death are taking place; one must have a knowledge of the sanitary environmental situation. These data will enable the medical officer of health to determine the

relative importance of the various health problems and to arrange accordingly his programme of attack. The survey will give him this information.

The workers must know the people and the people must know the workers. The villagers should understand why the workers are there, what they intend to do, and what they expect in the way of help. When the staff members have gained the confidence of the villager through the home-to-home visits they will find that the task has been greatly simplified. It has been the experience of a large number of workers that failure to receive co-operation from villagers has been due for the most part to the fact that the staff workers did not know the villagers sufficiently well and consequently had not secured their confidence and support. The survey furnishes a splendid opportunity for the health unit staff and the villagers to become acquainted.

Finally the data gained from the survey will form a base line of comparison. In a few years it will be necessary for the medical officer of health in charge to measure the progress which has been made against the situation which was found before any work had been done. The survey will supply this early data.

From these statements you will perceive the reason for placing this important subject first on the list and the necessity for spending considerable time on it. The health unit organization cannot use its time to better advantage for the first six months than in carrying out the necessary surveys, and it is probable that for this reason some health units have adopted as a slogan the expressive phrase, "Know your area, know your people."

TREATMENT

For a long time the position in respect to each other of curative medicine and of preventive medicine was not well defined. At one time the two branches were separated by a wide breach. In later years the trend has been for the two groups to come closer together, but even today it is difficult to decide upon the proper authority in respect to an epidemic of smallpox. Who is to vaccinate and who is to treat the cases in the infectious diseases hospital?

The health unit has been accused of opposing all treatment. This is not accurate. One of the requirements in selecting an area is that it should have a hospital and other treatment facilities staffed

by curative, but not health unit, officers. The medical officer of health and the medical officer give anticholera, antiplague and antityphoid inoculations and in an emergency any needed medical attention. In their training sanitary inspectors and public health nurses are instructed in the giving of mass quinine treatment, and mass hookworm treatment, and in home demonstrations of methods to combat scabies and pediculosis and other minor items.

As developed in this part of the world health units have avoided treatment as a major objective in so far as treatment refers to the setting up of dispensaries which are kept open daily to treat all ailments. The reason for this was and is sound. Curative medicine had long been established and dispensaries had been organised in all parts of the country. If the health unit had opened additional dispensaries it would only have duplicated existing facilities. Furthermore when dispensaries are established experience has shown that the tendency has been to neglect prevention and to give first attention to treatment. Dispensaries keep the staff at a fixed point and prevent the workers from visiting the field which is the proper area of their activity. There is no doubt that offering treatment is the easiest way to reach the people because they know nothing else about medical procedures. Sound public health work accentuates methods for keeping people well. It might almost be said that dispensaries put a premium on illness if a villager is to receive attention. All in all the matter resolves itself into the question as to whether one is going to spend his efforts on trying to keep the people well or on following the easy route of treating them after they become ill. Is he going to try to eliminate causes or to take care of effects? If treatment were the main consideration there would be no point in your coming to this Institute for additional qualifications.

In giving utterance to these statements no attempt is made to minimise the value of treatment. When treatment is needed it should be given at a proper place and by a properly designated staff. Nor is any attempt made to discuss the type of health organization which should be developed in a country to attain all these ends. These remarks are confined to this particular method of health procedure.

CLINICS

Health unit clinics in India are established for maternity and infant welfare work and for no other

purpose. The reason for this lies in the fact that health visitors rather than public health nurses are assigned to the work and, as the training of health visitors has been solely in maternity and infant welfare work it is not possible for them to undertake other activities. In most countries the public health nurse has a wider training and a wider field of activity. She does maternity and infant welfare work, but in addition she does clinic work and home visiting work in respect to tuberculosis, venereal diseases, nutrition, school health and in some instances has successfully invaded the sphere of the sanitary inspector in order to have latrines constructed. The key to useful public health work is often found in the influence which the female members of the staff have with the feminine members of the household. Were this staff member's training based on knowledge gained as a trained nurse rather than on knowledge gained as a trained midwife the range of the work of the public health nurse could be widened to the advantage of the public health programme and to the benefit to the people of the country.

Maternity and infant welfare clinics are now held *weekly* for the most part. This time sequence is empirical and has been adopted from other countries. A desirable attitude which ought to be developed early would be the determination of a sound basis for estimating the frequency with which clinics should be held. Holding clinics the same day each week enables the date to be followed more easily, but as a matter of fact attendance at the clinics is a responsibility of the health visitors so that they are the only people who really must remember dates. If the same results could be obtained by having *fortnightly* or *monthly* clinics, and some evidence is already available in support of the fortnightly clinics, it is obvious that an immense advantage would be gained, since additional clinics could be established thus bringing each clinic nearer to the home of each villager.

Based on experience the best results are obtained when the *well-baby* and the *prenatal* clinics are separated. There is a disinclination on the part of the expectant mother to assemble with a large group unless the group is coming together for a similar purpose. The attention they receive is different from that at the well-baby clinic which is often so well attended that it is not possible to give the requisite attention to the expectant mothers.

The practice of persuading mothers and children to attend clinics by offering drugs, food, toys, and similar enticements is not a good one and has no sound health foundation. Experience has shown that as soon as these inducements are omitted the attendance drops, since the mothers seem to have no other good reason for visiting the clinic. It is an evidence, therefore, that the health visitors and other members of the staff have not done their full duty, which includes placing emphasis on the permanent value which attendance at the clinic will have on the health of the child.

It is left to your common sense to think upon the advisability of bringing sick children to clinics to mix closely with children who are well. If our ideas of communicable diseases are sound, infections in such assemblies will be transferred from those who are ill to those who are well.

LEGAL POWERS

This subject is introduced because one has so frequently heard from medical officers of health that they cannot get the people to co-operate unless they can compel them to do so by law. When this complaint is made one is tempted to conclude that the medical officer of health might have done better in law or in police service.

At the same time it is realized that it is essential for every public health department to have a legal sanitary code to which resort can be had as needed. But legal powers should be used sparingly, preferably as a last recourse. The danger frequently found is that the medical officer of health and his staff are tempted to rely too much on the code and to prosecute the villager if the work which is suggested is not properly and quickly executed. Thus by this action the health official transfers the work for which he is responsible to the law courts. In order to get the courts to act he must be present to give evidence. He is thus kept away from his proper work in the field. If he wins his case, or if he loses it, he has alienated goodwill in the community and has made an enemy of the person prosecuted and of all his friends and relatives. And hence it might be said that the last state of the situation is worse than the first.

A medical officer of health who cannot get 80 per cent of his work done without recourse to law should feel that he has failed in his approach to the

people with his problems, and this situation should indicate to him an early and careful analysis of himself and of his methods.

Your indulgence is asked in giving an illustration from an actual occurrence. When the first health unit was started in an eastern country the statement was made in the opening ceremony that four sanitary inspectors would be stationed in an area which previously had had only one inspector. The people at once protested vigorously stating that one such evil was enough and that the burden ought not to be increased fourfold. There was a reason for this attitude by the people. The old inspector had spent most of his time in the court-house engaged in prosecuting the people for minor infractions of the law and had neglected his fundamental duty of mingling with the villagers and working with them in a sympathetic way in the approach to their health problems. Although the people were assured that nothing of the sort would occur in the new unit yet it was not until two years had elapsed, without prosecutions, that they were convinced that inspectors could be true friends and true helpers. As a matter of fact since those early days the sanitary inspectors have joined heartily in the work and have made some worthwhile suggestions in regard to carrying out certain phases of sanitation work.

CONFERENCES

Group conferences are recognized procedures in all well run activities. It has been stated by the medical officer of health who had most to do with developing health unit work in this part of the world that the weekly conferences of the staff were so important that they could not be omitted. This statement is no exaggeration. The staff does not work in watertight compartments, each one exclusively for himself, but all work together as a unit. The problem of one is the problem of all. They deal with the same people and are aiming to attain the same ends. A clear statement of a difficulty which one member of the staff has to contend with, followed by discussion and decision, is helpful to the whole group. The weekly conferences tend to keep the staff members interested in the entire health unit programme thus making for higher standards of excellence.

Occasion is taken at the conferences to prepare advance programmes. After the general conference is ended a paper can be read by a member of the

staff on some aspect of the work or a short talk by a visitor can be arranged for.

CO-OPERATION

The value of co-operation cannot be over-emphasized. It is the foundation of all public health work. Unless the people concerned help, the work cannot be successful in India or in any other country of the world. It is not enough to secure the co-operation of those in the immediate neighbourhood of the clinic or of the centre or of the subcentres. All the people, including those in remote parts of the area, must be reached.

It has been the general experience of health workers that people will co-operate if the necessary information is clearly and convincingly put before them in respect to the problems found in the area and the methods to be followed in solving them.

Public spirited citizens of the province and wealthy people living in the area can provide at their own expense suitably furnished central offices, clinic buildings, wells, pumps. This type of co-operation is indispensable and acceptable, but, as good as it is, it is less useful than the daily assistance rendered by the people of the area in cleaning up the surroundings, in ventilating the houses, in getting every one protected from smallpox through vaccination.

There are definite items of work which the villagers can do themselves under guidance, and the best method of obtaining their co-operation in this respect was suggested by a sanitary inspector in Ceylon who inaugurated the formation of *health leagues*. A health league is only one form of a village panchayat in which each village organizes itself to do a particular kind of work. The entire village population constitutes the league membership and at meetings any member of the village community is free to offer suggestions or to discuss proposals. The usual procedure is to form a small committee consisting of a chairman, a secretary and three or more members of the village. This committee meets monthly and records its deliberations in a minutes book. A member of the health unit staff attends the meetings by invitation and gives the committee the benefit of his technical knowledge. As a result at one of the early gatherings a programme is prepared containing various items of work to be attempted and the order in which they are to be taken up. These details

include clean-up days by sweeping and by removing the cattle to the borders of the village, vaccination against smallpox and other diseases, putting ventilators and windows in homes, digging bored hole soakage pits and bored hole latrines, collecting vital statistics, and attending to other similar village needs. The principle of the health league calls for the completion of one activity before the next task is started. The stimulus for completion comes from the league and not from the health unit staff and this is particularly true if the next subject on the list is something which the villagers greatly desire. This principle makes for completed work and avoids the usual procedure of doing a small amount of work on a large number of problems, completing none.

The first organization which started this activity in India was the Partabgarh health unit in the United Provinces. In this particular feature it can be definitely said that Partabgarh leads all other health units in India at the present time. It would be possible to visit any village in which a league exists and to learn that everyone, young and old, had been vaccinated against smallpox, that all homes were ventilated, that each home had a bored hole soakage pit and bored hole latrine, and that all occurrences of births and deaths had been accurately recorded. In respect to environmental sanitation and inoculation the league has improved matters beyond all recognition. The reason for its success is due no doubt to the utilization of the panchayat principle which is universally understood in India and is clearly appreciated by all village bodies. It is probable that the development of the health league idea is the most important contribution to general sanitation which the health unit system has yet made to the cause of public health. The health league method of approach has secured co-operation by the men. Could not a similar approach be made to secure the co-operation of the women in respect to their particular health problems? The public health nurse could study this problem with the village women.

INSPECTIONS

No work can be successful or lasting unless the requisite attention is given to it. If one secured the finest seeds and planted them in the best soil the growth would be disappointing unless constant attention were given to the weeding, the stirring of the soil, the keeping out of harmful animal and vegetable elements. In other words your harvest is

going to reflect the attention given to the choice of seeds and site, but, most important, to the cultivation of the crop. In health unit work care should be exercised in the location of the area of activity and in the selection and training of the staff. If, however, no further attention were given it is not unreasonable to expect that failure would follow. As a matter of fact inspections are an indication of interest and one cannot presume that a subordinate will show more interest in an activity than is shown by the responsible person who is in charge of the work.

By inspections, one does not refer to visits for destructive criticism, for "ticking off" the workers for this and that, and for threatening them if certain things are not done. An inspection is a friendly visit for gaining information, for discussion of problems, for giving advice out of one's larger experience, for working with the field man to find out his difficulties and for suggesting means of meeting them. It can be stated definitely that inspections of this nature are welcomed; they are looked forward to and are stimulating both to the visitor and the visited.

Careful inspections will reveal that health units are not static, that they are moving forward. The health unit of 1940 at Kalutara in Ceylon is far different from the same health unit which began there in 1926. Progress has been made each year. The Kalutara unit has kept up with that progress and in fact has created some of the progress. If you wish your work to be interesting, to be successful and progressive you must study it and yourself constantly. By way of illustration please consider the motorcar. In 1920 the motorcar was a comfortable, reliable vehicle which would take one to his destination more quickly than other means of traffic then known on the public highway. Conceivably the motorcar manufacturers might have said to themselves that they had a good product which required no further attention. No one could have criticised the manufacturer because general knowledge did not go beyond the principles then known and introduced in the manufactured article. But to the great credit of the motorcar makers it must be said that they felt that perfection had not been reached, and by means of research and by giving careful attention to engineering and to the criticisms of the public have produced the 1940 motorcar, superior to its 1920 prototype in four wheel and hydraulic brakes, electric lighting, self starting, streamlining, tyres, ability to hold the road, speed. As collateral developments

there are the good roads. Who would now buy a 1920 car or be satisfied with the 1920 roads? Should not the same idea hold good in health unit work? One could take up an activity, study it, discuss it, try out the new idea, accept or discard it as needed. Who knows the proper interval between clinics, the most satisfactory information to collect in surveys, an adequate method of obtaining correction of the defects found in school children, the best approach to tuberculosis and venereal diseases control, the amount of training required for the medical officer of health, and public health nurses, the standard health unit population, the relation of the public health programme to the whole needs of the community? Where are these answers to come from? They *can* come from those who are actually doing the work in the field. It is possible to set certain tasks for study, to prepare the forms, to collect the data, to analyse it, to draw conclusions from it, to put the conclusions into practice. Inspections which bring out such points for discussion are the inspections which have value.

PERMANENCE

The thought has no doubt occurred to many of you as to the place the health unit will occupy in the health organisation of the province after a period of five or more years. What will be its ultimate fate ten years hence when its initial purpose has been accomplished? Since the health unit idea was not known in India ten years ago it would not be prudent to try to foretell its position ten years hence. It would be a rash person who would venture to make a dogmatic statement in 1940 in regard to the status of any public health project in 1950. The present trend is towards increasing the number of health units in India. The matter of increasing the number in any single state or province rests upon the public health policy of the state or province concerned.

The question has often been raised in respect to the advisability of moving the unit to a new location after a five year period. The motive behind this suggestion is commendable. It indicates that the work has been appreciated and connotes a desire that its benefits ought to be enjoyed by other communities. But would the method suggested, that is, moving it, bring this about? If the unit were uprooted experience has shown that it would take nearly five years to get it settled elsewhere. A health unit is not a suitable place for training until it has had three years

of operation to consolidate its methods. If this procedure of periodic moving is followed health unit standards and principles would soon be lost and training facilities would be non-existent. A more suitable method would be to permit the unit to remain in its original location and to send staff members from various parts of the province to the unit for training. On returning to his area the staff member could develop his work on health unit lines so far as personnel and budget made this possible.

To arrive at something more definite it would be well to review the purposes of health unit work. These have been stated in print to be as follows: (a) To carry out sound health work of all types in a selected area; (b) to set up a model organization which could be closely studied by officials and technical visitors; (c) to demonstrate modern methods of practical approach to health problems which might be applied generally; (d) to develop a field training centre for all grades of public health personnel in the department.

If none of these objects have been attained the work should not be continued a single day after that point had been established. Assuming that the health unit has been properly organized, properly staffed and directed, and has been successful it is possible to assert that an organization for carrying out sound health work in the selected area has been developed and is still functioning; that an organization has been set up which has met the requirements of government officials and has been a stimulus to technical visitors from home and abroad; that this organization has opened up new avenues in dealing with public health problems which are practical for the province as a whole, and that a field training centre for all grades of personnel in the department has been established and is in use. Would it be wise to move such an organization?

The first health unit if carefully selected and developed should be made at the earliest possible date a permanent part of the provincial public health department. It should remain where it is; its roots should not be disturbed. The need for it as a training centre will increase each day. In that capacity it will serve as a field laboratory for testing out methods, procedures, and technics before applying them to the country as a whole. By pursuing this plan it will be found out in advance whether or not it would be worth while to set up a province wide public health programme on any particular subject without investing large sums to gain this knowledge.

It is thus seen that the ultimate primary function of the first established health unit in a province is its use as a school for giving practical field training to the public health personnel (medical officers of health, health visitors, sanitary inspectors, midwives) of the department. In such a capacity it must be permanent.

It has been stated that 80 per cent of the people of India live under rural conditions. Although one is aware of the serious and often deplorable public health problems which await solution in many of the large cities in India yet one does not hesitate to say that the public health problems of India which require most attention are found amongst that 80 per cent of rural population. To quote from a previous article, in rural areas,

The means of raising revenue are often unsatisfactory; the distances to be traversed are great; communications are frequently bad; and the general educational, financial, sanitary levels are low. On the other hand, rural areas contain the greatest number of people and as they are the main sources of wealth of the world their sanitary environmental conditions should be promoted.

Since these words were written in 1933 it should be added that all public health problems, as well as

sanitary environmental conditions, should be promoted. Experience has shown that the health unit system will aid in developing better public health conditions in rural and semi-rural India.

You have now had described to you some of the factors relating to health unit work in India in 1940. You know the general setup and you have been made aware of some of the details which are considered to be essential for success. You have heard a recommendation for permanency. The time has now come for an appraisal of the work. Are the present standards suitable or are new standards desired? Are its capacities to be enlarged or decreased? Are its functions to be changed? On some of you who are now listening in this room may rest the responsibility of describing the health unit system as it is found in India when the year 1950 appears on your calendar.

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Jacocks, W. P., Ceylon Health Units, *Indian Medical Gazette*, Vol. LXVIII, No. 6 (June, 1933), pp. 332-338.

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Research Notes

Bio-synthesis of Vitamin C

A CAPACITY for synthesizing vitamin C is evidently common to all the higher plants and to all the animals that have been studied hitherto, except guinea pigs, man and other primates. Simpler types of organisms such as bacteria and yeasts also have a capacity for synthesizing the vitamin. It has not, however been possible to demonstrate clearly the nature of the substance or substances and the mechanism involved in this synthesis.

In order to throw some light on this problem King and his associates have conducted a series of investigations, results of which have been embodied in several communications. In a recent paper (H. E. Longenecker, H. H. Fricke and C. G. King, *Jour. Biol. Chem.*, 135, 497, 1940) they have shown that several new series of compounds are as active in stimulating ascorbic acid excretion as the terpene-like cyclic ketones on which they had reported in previous communications (*Ibid.*, 129-130, 437-453, 1939). These new active substances differ greatly in chemical structure but they have a common characteristic, namely that they function as nerve depressants. Among the most active compounds are four series of anaesthetics and two antipyretics.

These data considerably extend the number and types of molecular structures which produce accelerated ascorbic acid synthesis. The authors point out that the vastly increased excretion of ascorbic acid which follows the administration of these substances, make it improbable that they are direct precursors of the vitamin. The data are said to point rather to a probable stimulation of the synthesis of ascorbic acid from some unknown metabolites by these nerve-depressants.

S. R.

The Intracellular Inclusions of Some Virus Diseases

INTRACELLULAR inclusions have not been found in all virus-infected plants, but these are found to be quite common in some of them. Their production depends more on the nature of the infecting

virus than on the species of the plant infected. For example, they have been found in a number of different species infected with tobacco mosaic virus, but not in any of the same species infected with potato virus Y or cucumber virus 1. It is not doubted that they are formed as a result of virus infection, but different workers have held widely divergent views as to their nature and significance. Some have regarded them as amoebae or as stages in the life-history of a causative organism, to which names have occasionally been given, while others have regarded them simply as masses of coagulated cytoplasm.

It has been found that plants infected with certain virus contain proteins not present in healthy plants. These proteins have the characteristic properties associated with the different viruses. Changes in them result in loss of infectivity, and it is highly probable that they are the viruses themselves.

The greatest difference between a healthy and an infected cell is the formation of the characteristic inclusions in the latter. In 1903 Iwanowski described two main types of inclusions in tobacco mosaic plants, one consisting of amorphous material, later named *N-bodies* by Goldstein (1924) and the other flat crystalline plates. The three strains of tobacco mosaic virus, *viz.*, those causing common tobacco mosaic, Enation mosaic, and Aucuba mosaic, have been studied by Bawden and Sheffield (*Ann. Appl. Biol.* 26, 102, 1939). All of them cause formation of the two kinds of inclusion. No significant differences have been found between the crystalline inclusions produced by the three strains, but the amorphous body of Aucuba mosaic differs in some respects from those of tobacco mosaic and Enation mosaic.

The amorphous bodies of all three diseases are relatively stable entities, are preserved by ordinary cytological fixatives and give all the usual protein reactions. They average about 10-30 μ in length, contain vacuoles, chondriosomes, and oil globules, and as they are carried round the cell by the streaming cytoplasm they frequently change their shape.

The crystalline plates may occur in large numbers either alone or in the same cells as harbouring the amorphous bodies. They are best examined in fresh living cells, because fixation destroys them or causes the formation of numerous striations. Like the amorphous bodies the plates give protein reaction, but they are extremely fragile and either disappear or alter in appearance if the cell is injured in any way. They are true crystals with a three dimensional regularity, and as they slowly move around the cell and turn over, they show both side and end faces. When seen in the basal plane some plates are regular hexagons, with all their angles 120° . The authors note one important difference between the artificial complexes produced with the purified viruses and the intracellular inclusions, the former are paracrystalline whereas the latter are true crystals.

It has been shown that insoluble complexes of the viruses with protamines, histones and proteins which in many ways resemble the intracellular inclusions can be produced *in vitro*. Possible explanations for the formation and disappearance of the inclusions in infected plants are suggested in the paper.

In tobacco and all other Solanaceous plants infected with severe etch virus, two kinds of intracellular inclusions have been found by Basilios Kassanis (*Ann. Appl. Biol.*, 26, 705-9, 1939). One is an amorphous cytoplasmic inclusion which has been described in many other virus diseases of plants. The other is an *intranuclear inclusion* and appears to be crystalline, having the form of thin rectangular plates. The simplest method for differentiating the intranuclear crystals is to mount an epidermal strip in an aqueous solution of eosin. The best method for staining fixed preparations is that of Kull, using acid fuchsin, toluidin and aurantia: the crystals and the nucleoli stain red and the chromatin blue. With Heidenhains haematoxylin the crystals stain black, and when placed in solution of iron alum they retain their colour longer than any other of the cell contents.

A. B.

The Utilisation of Carbon Dioxide in the Synthesis of α -ketoglutaric Acid by Pigeon Liver

THE processes of absorption of carbon dioxide and the manufacture of carbohydrates from it and water in presence of sunlight by the chlorophyll containing vegetable tissues have long been known. This has so long been the only mechanism in living cells where carbon dioxide is utilised.

It has been recently reported by Evans and Slotin (*Jour. Biol. Chem.* 136, 1940) that carbon dioxide is also assimilated by animal tissues. They have shown that pigeon liver can synthesise α -ketoglutaric acid from pyruvic acid in presence of bicarbonate medium (pH 7.4) in which the bicarbonate had been prepared from radioactive carbon (C_{11}) obtained by the bombardment of boron with deuterons.

Ketoglutarate was precipitated as the 2:4 dinitrophenylhydrazone. The precipitate after thorough washing with 10 per cent. HCl and drying *in vacuo*, melted at 222° (uncorrected) and showed no depression of the melting point on being mixed with a sample of the hydrazone. The substance was intensely radioactive and contained about 3 per cent. of the added activity.

Since pigeon liver has been found to synthesize α -ketoglutaric acid from oxalacetic acid plus pyruvic acid, the data suggest that carbon dioxide combines directly with pyruvic acid to yield oxalacetic acid, the latter then combining with an additional molecule of pyruvate to build α -ketoglutaric acid.

P. K. S.

A New Dietary Essential for the Mouse

RATS and chicks have been extensively used in connection with experiments on the vitamin B-complex but surprisingly enough mouse has not been used for such studies. While experimenting with mouse, D. W. Woolay reports (*Jour. Biol. Chem.*, 136, 1940) that a synthetic diet, which is adequate to maintain rats in a normal condition, is not sufficient to keep mice in a healthy and normal condition. Young mice soon cease to grow and hair on the entire body, with the exception of the head and tail, fall out leaving the trunk naked. Soon sores appear. The mice become hyperirritable and muscular inco-ordination develops. Unless some active concentrate is given the mice die within 2 to 3 weeks from the onset of the symptoms. Muscular inco-ordination was cured by feeding a norit eluate of the alcohol-soluble fraction of liver extract. This eluate however failed to cause the growth of hair. The most active source to cause the growth of hair was the fraction of aqueous liver extract which was insoluble in 70 per cent. alcohol. The active substance is non-dialysable and has not been identified with any previously described vitamin.

A. R.

BOOK REVIEW

Organisers and Genes—by DR C. H. WADDINGTON.
Published by Cambridge University Press, 1940.
Pp. $x+160+2$ plates and 15 text-figures. Price
12s. 6d.

The new science of experimental embryology, the foundations of which were laid by His, Roux, Hertwig, Driesch, Herbst and others in the latter part of the nineteenth century, has accumulated a vast body of facts, and biologists are now busy in sifting and analysing this material so as to be able to formulate general principles. Dr Waddington's excellent manual is a contribution in this direction and provides a synthesis between genetics and developmental mechanism.

Students of embryology are familiar with the fact that soon after the cleavage of the fertilized egg leading to the blastula stage, developmental processes set in, which, broadly speaking, lead to a visible differentiation of the embryo. This early differentiation includes the formation of the rudiments of the neural tube, the notochord and the somites. Differentiation, at first morphological and histological, and later functional, is, in fact, the essence of the development and growth of the embryo. What is the causative agent of this differentiation occurring in the embryo just at this particular time? In 1918 Hans Spemann discovered that the dorsal lip of the blastopore in the Amphibia determines the position of the axial structures, and later Spemann and Mangold (1923-25) demonstrated that the dorsal lip does more, it itself induces the differentiation of these axial structures, and they, therefore, designated it as the "organiser". This basic discovery of "organisers" has opened a new field for research and already the concept has been extended to other groups of organisms (*e.g.*, the *primitive streak* is the organiser in birds), and to other stages of development. Further analysis has proved that the position of the dorsal lip of the blastopore is determined by that of the grey crescent, and the latter by the point of sperm-entry. Thus we are now able to understand many processes of development which were previously obscure.

In analysing the organiser action, Dr Waddington makes a distinction between the two-fold action of an

organiser and calls the inducing action as such as "evocation", and the determination of its regional character as "individuation". But the main thesis of the book is to obtain an understanding of the mechanisms involved in differentiation from a consideration of unit hereditary factors or *genes*, which have been postulated by the brilliant researches of Morgan's school of genetics. In successive chapters the author deals with the nature, quantities and kinds of the substances produced by the genes, the localisation of gene effects, the pattern effects of genes, the temporal course of gene reactions, evocator-competence reactions, morpho-genetic movements, and growth in relation to the organiser phenomena. The last chapter on the theory of organisation deals with the concept of fields, essentially an advance in methodology, complementarity, and the relation of science with philosophy.

The important part played by the genes in controlling the processes of development and differentiation is fully brought out by a judicious marshalling of the large body of experimental evidence, and the author is to be congratulated on the production of a handy volume on the subject, following his excellent book on *Modern Genetics* published only last year.

K. N. B.

A Text Book of Sound for B.Sc. Students—
by R. N. GHOSH, D.Sc., Reader in Physics, Allahabad University, and R. N. RAI, M.Sc., Lecturer in Physics, Allahabad University. Published by the Indian Press, Allahabad, 1940. Pp. 353 with 200 diagrams and 16 tables. Price Rs. 5.

No one would venture these days the statement, 'all (of acoustics) is in Rayleigh', and yet it was considered to be a truism not many years ago. It is radio (and perhaps also war) which has directly or indirectly brought into being much of what may be called modern acoustics, and fittingly the opening sentence of the new text book of sound by Dr R. N. Ghosh and Mr R. N. Rai reminds us of it. The senior author, who is a teacher of wide experience,

has been an untiring investigator of the subject he deals with in this book, and a book by him cannot but be, and as a matter of fact, is up to date, and the treatment is within the reach of those for whom it is intended. Dr Ghosh has been fortunate in having Mr Rai as his collaborator, who, though not so widely known, is esteemed by all who know him for his clarity of ideas and grasp of fundamentals.

The authors have succeeded in producing an excellent text book on sound for B.Sc. classes. The reviewer considers that no other text (of B.Sc. standard) on this subject can supersede it. And all this can be said in spite of a few oversights which are to be found at some places. On page 92 an otherwise clear discussion is vitiated by the statement that (a) is independent of time, which it is not; on page 119 power is confused with energy (*sic*)—10 micro watts or 100 ergs.; the units should have been stated in giving the numerical values of the quantities on pages 64, 93, 98; the statement about transverse Doppler effect on page 111 is distressingly vague and the quotation from Barton left unexplained; but such oversights do not essentially detract from the value of the book. They will easily be corrected in the second edition when opportunity undoubtedly would also be taken to improve some of the figures and the printing at some places.

The book is divided into nineteen chapters and has at the end twelve pages of mostly university questions. It describes acoustic impedance, valve oscillators, talkie, total reflection of sound, Raman's theory of bowed strings, and gives life-sketches of the great investigators in acoustics. It appears that

nothing of any importance has been omitted (Fletcher's auditory patterns may be included in the second edition).

The reviewer considers the book to be on the whole a very valuable one, and the authors deserve to be congratulated for producing such a useful and entertaining text.

D. S. K.

Symmetric Functions in the Theory of Integral Numbers—by HANSRAJ GUPTA. Lucknow University Studies, Faculty of Science. No. XIV, Pp. 105. Edited by B. Sahni, Sc.D., F.R.S.

In this book is embodied a short course of lectures on the theory of integral numbers delivered by the author at Lucknow University, in which investigations made by the author himself have been also incorporated. Other names may be mentioned in connection with the line of work done by the present author: S. Ramanujan, B. B. Datta, A. N. Singh, S. S. Pillai, N. B. Raju, N. Rama Rao, Hemraj and a few others, including the Chowla brothers. The book is devoted to only four chapters, but the fundamentals have been presented nicely and concisely. In this book many important theorems have been dealt with, *viz.*, those of Fermat, Lagrange, Wolstenholme, Wilson, Leudesdorf, Gauss, Von Staudt and Bauer. The book, we have every reason to believe, will provide very useful rudimentary material for a study of the theory of numbers to those interested in the subject.

K. B.

LETTERS TO THE EDITOR

Fairy Rings of Mushrooms in Calcutta and its Suburb

Fairy rings have been figured in many advanced text-books of mycology of Europe, America, Australia, and Japan, with photo-prints. In July and August, 1940 a wide fairy ring (35 ft. in diameter) of edible *Lycoperdon* was found in the lawn on the southern side of the Herbarium of the Royal Botanic Garden, Sibpur. It had a bare zone at the centre followed by two stimulated zones (here the grass was tall and dark green) on either sides (Fig. 1) extending over 12 to 18 inches. The soil below the surface of the central part of the ring was full of a network of hyphae of *Lycoperdon* which resembled very fine strands of cotton while the subsoil on two



FIG. 1

- (a) A portion of the fairy ring found in the Royal Botanic Garden, Sibpur, with fruit-bodies of *Lycoperdon*.
(b) A fruit-body of *Lycoperdon*.

sides was almost devoid of any hyphae. Another fairy ring of *Lycoperdon* with a diameter of 20 ft., occurring on the maidan in the eastern side of the Fort William was noticed in September by Mr S. N.

Banerji of the botany department of Calcutta University. Prof. Buller in his '*Researches on Fungi*', (Vol. 2, pp. 365-366, 1922) has recorded from California (U. S. A.) a very big fairy ring of puffballs (*Lycoperdon*) with a diameter of 211 ft. enclosing a number of smaller rings of *Psalliota campestris* within its boundary.

Roots of grass from four spots on the fairy ring of the Royal Botanic Garden, viz., the area inside the ring, the ring itself, and the two sides of the ring, were sectioned and examined under the microscope. Several species of grass were found growing in the area, viz., *Chrysopogon aciculatum* Trim., *Paspalum scrobiculatum* L., *Paspalidium flavidum* A. Camus., *Setaria glauca* Beauv., *Fimbristylis dichotoma* Vahl., *Rottboellia compressa* Linn. f. etc. Roots of grass from the region of the ring showed numerous vesicular and arbuscular hyphae in their cortex without any clamp-connexion while those from the other three regions were remarkable for their scanty hyphae. A fungus was isolated in pure culture from the roots of the grass growing on the ring. It took deep stain with cotton blue and lactophenol. The mycelium was septate and branched and produced several spirals. It was found to be almost identical with the "harmless endophyte" described by Miss Sampson¹. She isolated a similar fungus from the leaves of *Lolium perenne* and provisionally named it as the second endophytic fungus of *L. perenne*. Inoculation-experiment on grass roots was carried out with this fungus but it seemed to produce no ill effect on the grass so treated. Thus, we may hold that the intracellular hyphae found in the cortex of the grass roots belong to a harmless endophyte not connected with the formation of the fairy ring. In August, numerous fruit-bodies of *Lycoperdon* sp. appeared on the bare zone in the ring; the soil below the bare zone was found to be packed with a vigorous network of hyphae of *Lycoperdon*, these hyphae developed in the soil without entering into the roots of the grass. Owing to the presence of the hyphae rendering the ground impervious to water, the vegetation suffered and thus arose a bare zone. In September, the bare zone was followed by a dark

green zone of grass no longer showing any formation of fruit-body of *Lycopodon*; this dark zone was associated with degenerating mycelium inside the soil. The soil from this area, tested chemically, showed presence of ammonium salts. Thus, the bare zone was eventually recovered by the liberation of nitrogenous materials leading to the stimulation of the grass in the area.

Krieger² has mentioned three types of fairy rings, viz., one with a central bare zone followed by two stimulated zones on either sides, another with a dark green zone, and a third in which no effect is visible.

I am grateful to Dr K. P. Biswas, the superintendent, and Dr S. K. Mukherjee, the curator of the Herbarium of the Royal Botanic Garden, Shibpur, for kind help in this work.

Carmichael Medical College,
Calcutta, 14-11-1940.

A. B. Bose

¹ Sampson, K., *Trans. Brit. mycol. Soc.*, 21, 84, 1938.

² Krieger, L. C. C., *The Mushroom Handbook*, New York, 1936.

Meteorite in Ajmere

A most extraordinary meteorological phenomenon occurred at about 9-20 on the night of the 7th September, 1940. A meteorite of unusual size and brilliance shot across the sky right overhead of us from east to west throwing out sparks of white light in profusion on either side of its dazzling trail paling the electric lights all round for a few seconds. It appeared to come down in a big curve, and as it neared the horizon, its head turned reddish and the streak behind bluish green. There was a thud like that of distant gunfire and a low roar for about a minute. The phenomenon was distinctly visible at several stations in the district as I have been informed. Even people enjoying a circus show at Beawar 32 miles S.W. of Ajmer, were attracted by this exciting object, and hundreds living in the open, in a Famine Relief Camp saw it. All declare that they never saw the like of it in all their life. Probably some of the villagers in Marwar living on the borders of Ajmer-Merwara, will be able to locate it.

The present writer will be glad if somebody could enlighten him about this phenomenon.

Husband Memorial
High School,
Ajmere, 23-11-40.

A. N. David

A Preliminary Note on the Isolation and Pathogenicity of *Acrothecium lunatum* Wakker and *Helminthosporium tetramera* McKinney on the leaves of *Oryza sativa* Linn

Various authors have investigated the fungi causing diseases of rice plants in different parts of the world. Extensive researches are still being done in India also. While examining materials of rice plants growing in the paddy fields of the Agricultural Research Station at Chinsurah and of Burdwan, Bengal, the authors noticed the occurrence of the following species of fungi. Most of the fungi so far isolated from paddy are recorded in *The Fungi of India*^{1,2}, but so far as the authors know there is no published record as regards the pathogenicity of these fungi on the leaves of paddy, although *Acrothecium lunatum* Wakker has been isolated from paddy-field-soil from Burma (Rhind) and from leaves of other Gramineae. The present note is a preliminary account of the work done so far. It is intended to publish a more detailed account later on.

Acrothecium lunatum Wakker

This fungus was isolated from paddy leaves brought from the paddy-field of Chinsurah in the month of July, 1939. The leaves, as collected in the field, were quite yellow showing a few brownish streaks. But, later on, small brownish streaks appeared in patches on the laminae. Small pieces of the infected parts were isolated following Davies' method³. The cultures were kept in diffused light and at room temperature. On the fourth day of inoculation, characteristic cottony fungal growth was obtained. Subsequently sub-cultures were made and in every case characteristic cottony growth started within 12 hours. In each case, the mycelium was dull grey in colour at first, but finally, with the production of conidia, the whole surface of the slant was covered with blackish brown mass. The conidia measured about $(21\mu-24.5\mu) \times (9\mu-12\mu)$.

Several successful inoculation experiments were made on the unwounded leaves of rice plants by spraying conidial suspensions and the pathogenicity of the fungus was thus proved. The streaks that were formed agreed in appearance with those found in nature. Re-isolation of the fungus was made for confirmation. The controls remained healthy.

Helminthosporium tetramera McKinney

This fungus was isolated from paddy-leaves collected from Burdwan in 1939, and the cultures were kept under the same conditions as before. Growth of the fungus appeared within 48 hours of inoculation.

In order to prove the pathogenicity of the fungus, a spore suspension was sprayed over a number of healthy rice plants, while several of them were kept as controls. After about a week, the sprayed plants developed yellowish brown streaks in patches on the laminae, while the controlled ones showed no such sign.

Re-isolations were made from the newly infected parts in the same manner, and under identical conditions the same results were obtained. The fungus when examined exhibited typical conidia of *H. tetramera* McKinney. They measured about $(15\ \mu-27\ \mu) \times (6.5\ \mu-9.5\ \mu)$.

Specific determinations of these two fungi were confirmed by Dr M. Mitra of the Imperial Agricultural Research Institute, New Delhi, to whom pure cultures were sent for the purpose. The authors' best thanks are due to him for this.

Lastly, the authors wish to record their deepest esteem and sincere thanks to Mr S. N. Banerji, under whose guidance the present work is still being conducted.

Department of Botany,
University College of
Science,
Calcutta, 26-11-1940.

Ajit Kumar Ganguly
Durgadas Ganguly

¹ Butler, E. J. & Bisby, G.R.—*Fungi of India*, The Imp. Council of Agricultural Res. Sci. Monograph No. 1, 1931.

² Mundkur, B. B.—Do supplement I, Sci. Monograph No. 12, 1938.

³ Davies, F. R.—*Canad. Jour. Res.*, 13, 168, 1935.

Fasciation in the Female Inflorescences of *Morus indica* Linn.

In course of field work, the writer came across four fasciated inflorescences and infructescences of different types.

In a grafted tree (provisionally marked No. 7G.) a case of fasciation in the female inflorescence was observed (Fig. 1.a). The length of the inflorescence is 13 cm. with the peduncle 5 cm. long. The individual florets are sessile and pressed together as usual. Each has 4 sepaloïd tepals and a syncarpous pistil. The ovary is unilocular by abortion, uni-ovulate, and has one style with two arms. Fasciation has taken place at the top of the peduncle where the inflorescences are joined together.

In the same tree two other fasciated infructescences were found. Here the lower portions of the infructescences had united to form a thickened structure, the apices being however free (Fig. 1., b & c). The infructescences are 25 cm. and 22 cm. long with the peduncles 5 cm. and 13 cm. respectively.

In another plant (provisionally marked Kurseong No. 15) another case of fasciation in the female inflorescence, very like that of Fig. 1. a, was observed. The length of the inflorescence is 10 cm. (Fig. 2). The peduncle is 8 cm. long.

Buonocore¹ examined many varieties of the mulberry and found some cases of fasciation (of different types) in the female inflorescences and infructescences of the variety *Morettiana* (= *M. alba moretti* Seringe) only. The writer however has observed this phenomenon in other varieties of *Morus indica* Linn. but not in *Moretti*.

The following views have been expressed regarding the cause of fasciation.

Plot, as referred to in Masters², considers fasciation to arise from the ascent of too much nourishment for one stalk and not enough for two.

Worsdell³ states that fasciation is often due to the flow of superabundant nutriment to the organ affected. He cites experiments of artificial nutrition thereby inducing fasciation.

Miller⁴ records that recently it has been found that certain definite carbon and nitrogen relations in

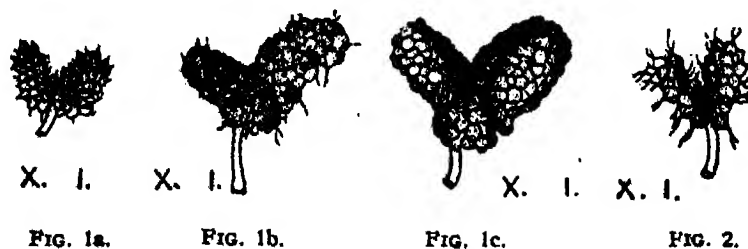


Fig. 1 a—Fasciated inflorescence. $\times 1$.

Fig. 1 (b & c)—Fasciated infructescences. $\times 1$.

Fig. 2.—Fasciated inflorescence. $\times 1$.

the plant influence its response in regard to vegetative growth and reproduction. This relationship of the carbon and the nitrogen contents of the plant has come to be expressed as the "carbon/nitrogen ratio". Fisher⁵ reports that the vegetative condition was characterised by a carbohydrate content relatively low in proportion to the nitrogen or by a low $\frac{C}{N}$ ratio; whereas the reproductive condition was characterised by a carbohydrate content relatively high in proportion to the nitrogen content, or by a high $\frac{C}{N}$ ratio. It is thus evident that excessive fruit-formation takes place when the $\frac{C}{N}$ ratio becomes very high.

Last year (March, 1940) the writer observed excessive fruit-formation in these trees possibly due to the high $\frac{C}{N}$ ratio along with cases of fasciation. He is therefore inclined to ascribe fasciation to the excessive flow of sugary sap into the reproductive parts and support the views of Plot and Worsdell.

In conclusion, the writer wishes to express his sincere thanks with gratitude to Mr S. C. Mitter, director of industries, Mr C. C. Ghosh, deputy director of sericulture, Bengal and Dr S. P. Agharkar, head of the department of botany, Calcutta University for their kindly going through the manuscript and suggesting improvements.

Sericultural Research Station,
Narayanpur Colony,
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1-9-1940.

R. M. Datta

¹ Buonocore, C.—Fenomeni teratologici in *Morus alba* L. Anomalie dell. apparato sessuale, *Boll. d. R. Staz. di Gelsicol. e. Bachicol. di Ascoli-Piceno.*, Vol. XVII, No. 3-4, Pp. 3-19, 1938.

² Masters, M.—*Vegetable Teratology*, Ray Society, 1868, p. 19.

³ Worsdell, W. C.—*Principles of Plant Teratology*, London, 1915, p. 95.

⁴ Miller, E. C.—*Plant Physiology*, with reference to the green plant, p. 543, 1938.

⁵ Fisher, H.—Zur Frage der Kohlensäure-ernährung der Pflanze, *Gartenflora*, 65, 232, 1916.

On Zoomeric Acid

Zoomeric acid, Δ^2 -hexa-decenoic acid found in cod liver oil as well as in oil from hump-back whale and the grey whale (of California) has been synthesised from aleuritic acid (obtained from crude lac) in the following manner:

To ethyl aleuritate (20 g.) in ethereal suspension, a solution of phosphorus di-iodide in carbon disulphide, prepared by gradually adding iodine (34 g.) to a solution of yellow phosphorus (4.2 g.) in the dry solvent (63 c.c.), is slowly added, a few c.c.'s at a time, with constant shaking. The sticky mass which separates at first is kept overnight. The contents of the flask are poured into ice-cold distilled water and the mixture extracted with ether. The ether-carbon disulphide layer is washed successively with water, sodium bicarbonate and sodium thio-sulphate. It is then evaporated first under ordinary and finally under reduced pressure below 50°C. It distilled at 180°/3 m.m.

6 gms. of the above iodo ester (Ethyl-16-iodo- Δ^2 -hexa-decenoate) was dissolved in glacial acetic acid (50 c.c.) by slightly warming on the water bath. Zinc dust (13 g.) were then added gradually and the mixture heated on the oil bath at 100°C for 4 hours and then at 125°-130°C for 2 hours more. After reduction, the mixture was diluted with ether and then filtered free from zinc dust and zinc acetate. The reduced ester was worked up in the usual manner with ether, and the ether driven off and distilled, b.p. 170°/6 m.m. Yield 3 gms.

The ester (3 g.) was hydrolysed by methyl alcoholic caustic potash (10% solution). The boiling point of the acid obtained is 160°/4 m.m. Yield 2 gms. (Found: C-75.0%, H-11.5%, $C_{16}H_{30}O_2$ requires C-75.5%, H-11.8%).

Palit Laboratory of Chemistry, P. C. Mitter
University College of Science, M. Sen Gupta
Calcutta, 7-12-1940.

SCIENCE CONGRESS SUPPLEMENT

To Science and Culture, January, 1941

-
- Sir Ardeshir Dalal's
Presidential Address
 - Benares—Its History and
Present Sights
 - Life Sketches of the
General President and
Sectional Presidents
-

Science and Industry

Sir Ardeshir Dalal's General Presidential Address at the Indian Science Congress, Benares

I FEEL that the authorities of the Indian Science Congress Association have made a very bold departure in electing a layman to the honour of the presidency for the year and, deeply conscious as I am of the honour, I confess to a feeling of diffidence in occupying a post which has been adorned by so many distinguished scientists before me. If my address falls short of the standard set by my predecessors, the responsibility of it should in part be borne by those who have elected me. The only reason for their choice, as far as I can see, lies in the fact that I may lay some claims to be an industrialist.

VALUE OF RESEARCH IN INDUSTRY

So close and intimate is the relationship between science and industry and so strongly is that fact being brought home to us in these days that the Association felt perhaps that they would like to have the views of an industrialist on the relationship of science to industry with particular reference to the practical problems which have arisen in India since the beginning of the war. A substantial part of the export trade of India has been lost since the war. Science can help in the utilization within the country itself of some of the raw materials which used to be exported. Researches are being conducted for instance on the use in India for lubrication purposes of some of the oil seeds of which the export has dwindled down and the surplus of which is likely to create serious economic trouble for the cultivator. Even a more acute problem is the stoppage of the import of many commodities essential for the economic life of the country, such as machinery, chemicals, etc. It is imperative that India should make herself self-sufficient with regard to such materials as are vital to the maintenance of her economic and industrial life so that the situation which had arisen during the last war and which has arisen once again may never recur. It is here that science can be of the greatest assistance to industry. Research has been described as the mother of industry and while some of the older and more traditional industries may have originated

without the aid of science, it cannot be denied that all industries to-day depend upon science and research not only for their progress and improvement but also for their survival. Sad experience has proved to us beyond all doubt that, under modern conditions, no nation, however peacefully inclined, can expect even to live an independent existence unless it is highly industrialized. It is the industrial potential that is convertible into the war potential and the country that has the highest industrial potential and is prepared to convert it in the shortest time into war potential that stands the best chance in modern warfare. As we have seen, it is not man power that counts in the highly mechanized warfare of the present day, but planes, tanks, guns, ships and the factories, plants and workshops behind them. The lesson for India is plain and she can only neglect it at her peril. It is no longer the question of a balanced economy or of mere material progress. It is necessary for India's very existence that she should be highly industrialized.

This lesson was first taught during the last world war. Owing to its superior scientific organization and equipment Germany was able to withstand the Allies much longer than she could otherwise have done. At the beginning of that war, England found that she was deficient in many forms of optical glasses, dyestuffs, chemicals and other necessities for the conduct of modern warfare. She set herself to remedy these drawbacks. A very important dye industry was created and the whole of the scientific and research talent of the country was organized by the creation of the Department of Scientific and Industrial Research. It is not necessary for me to enter into the details of the organization and working of the D.S.I.R. with which many of you must be familiar. An interesting feature of the organization, however, to which the attention of the authorities in India needs to be drawn is that the administrative organization of the D.S.I.R. is entirely composed of technical men, while the Advisory Council, which guides and controls its activities, is mainly composed of distinguished scientists with the

addition of two or three well-known industrialists and business men. The words of Lord Rutherford to the Twenty-fifth Indian Science Congress, though frequently quoted since then, will bear repetition as they have an important bearing on the policy of the Government of India towards the recently created Board of Scientific and Industrial Research. He said :

'In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the Government, rests with research councils or committees who are not themselves State servants but distinguished representatives of pure science and industry. It is to be hoped that if any comparable organization is developed in India, there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned. It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but of course the responsibility for allocating the necessary funds ultimately rests with the Government.'

There has been a tendency in the past in India for scientific and research work to be monopolized by Government Departments and although valuable results have been obtained, e.g., by the Survey of India, the Geological Survey, the Botanical Survey and in the investigation of tropical diseases, it is very necessary that organized industrial research should as far as possible be left to scientists and industrialists although of course Government has to see that the grants it makes are properly utilized.

BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Industrial research was organized on a country-wide basis in America as well as in several countries of the British Empire following the lessons of the last war. In India also the war revealed the helplessness of the country. The transport service was disorganized owing to lack of railway material; supplies of dyes, important chemicals and many important medicines were almost completely stopped and prices of textiles shot up so high as to be beyond the means of poor people. In 1915 the Government of India addressed the Secretary of State as follows :

'After the war India will consider herself entitled to demand the utmost help which the Government can afford to enable her to take a place, so far as circumstances permit, as a manufacturing country.'

This policy was accepted by the Secretary of State and the Indian Industrial Commission, under the Chairmanship of Sir Thomas Holland, was set up as a result. Unfortunately, however, the impetus to industrialization provided by the war died down after

a few years and many of the industries which were started during the war languished and died. The gathering storm clouds of a new world war drew the attention of Indian scientists to the unorganized state of scientific and industrial research in India and repeated appeals were made for the constitution of a body on the model of the D.S.I.R. The urgent need for the appointment of such a body was voiced by Professor J. C. Ghosh in his presidential address to the Association at Lahore in 1939 and was reiterated in a resolution of this body last year at Madras. The same point was made by Colonel Chopra in his presidential address to the National Institute of Sciences in Madras last year and by Sir M. Visvesvaraya in an address to the Indian Institute of Science, Bangalore. We, therefore, cordially welcome the recent appointment of the Board of Scientific and Industrial Research by the Government of India in response to the demand of scientists throughout the country. Our thanks are due to the present Commerce Member, Sir Ramaswami Mudaliar, who lost very little time in appreciating the urgency of the constitution of such a body under the conditions created by the war.

I am a member of the Board and keenly interested in its success. Any observations which I may make upon it are made in a purely constructive spirit with the object of enhancing its utility to the country. In the first place then, I may be permitted to say that although the beginning of the Board, like most beginnings, may be small, its conception must be large and liberal. It must not, in its composition or working, bear the appearance of a mere ad hoc body created to meet the immediate exigencies of the war. The demands of the war are no doubt urgent and must have priority over other demands, but the Board should function as a body charged with the organization and promotion of industrial research throughout the country, and co-ordinate the immediate needs of the war with the long range policy of the industrial development of the country as a whole. While concentrating on what is immediately required to meet war needs, it must also be in a position to survey the long term industrial requirements of the country and to plan a programme of research to meet them. Perhaps after the urgent demands of the war are over, its composition can be enlarged and made more representative of the universities, Government scientific services, the non-official scientific bodies and the industrialists of India so as to enable it to pursue its ultimate plan and policy.

No institution, however well conceived and designed, can flourish except in suitable political atmosphere and conditions. It was the unfortunate experience of the last war that industries created

under the stress of the war languished and died in the post-war period for want of encouragement and protection from Government. The activities of the Board will not lead to the creation of new industries unless industrialists are assured of reasonable protection from Government in the post-war period, when foreign competition will be keen.

I have already quoted the words of Lord Rutherford as a warning against excessive Government control. The progress hitherto made by the Board is not as rapid as we would have wished in war time. This is partly due to the constitution of the Board under which executive authority is concentrated in a central department of Government and partly to the inadequate staff provided for the very urgent and important work that has to be done. There is one other aspect on which I desire to touch and that is the financial. Even for a beginning, a grant of Rupees five lakhs is inadequate and shows to my mind an inadequate conception of the magnitude of the tasks involved. Associated with the Department of Scientific and Industrial Research in Great Britain are the great National Physical Laboratory at Teddington and important Boards, such as the Fuel Research Board, the Food Investigation Board, the Forest Products and Building Research Institutes and a number of similar bodies as well as Research Associations. While we must necessarily make a very modest beginning, the development of the Alipore Test House into a National Physical and Chemical Laboratory seems to be obviously and urgently required. In a subsequent part of this address I shall dwell upon the necessities of a Fuel Research Board to investigate the very pressing problems of fuel and power, upon which the whole industrial structure of the country has to be based. All this work will require large funds but I have not the slightest doubt that the money so spent will be repaid manifold. It has been estimated that the annual expenditure on research in Great Britain in normal times before the war was roughly six million pounds, of which one-half was spent on research directed to industrial needs, including the money spent by Government, university departments and private firms. The figure for the U.S.A. is estimated to be 300 million dollars, while the corresponding figure of the U.S.S.R. is reported to be of the nature of 120 billion roubles. With the exception of the U.S.A. and the U.S.S.R., there is no country in the world with natural resources so vast and varied as India. With the expenditure of even a fraction of the amount spent by the countries just mentioned on industrial research, these resources can be investigated and developed so as to place India in the front rank of the industrial countries of the world.

THE STEEL INDUSTRY IN INDIA

I propose now in the second part of my address to speak to you on some developments in the steel industry in India during the last ten years; but before doing so I should like to make a few remarks on the raw materials which are commonly used in the manufacture of iron, namely, iron ore, coal and limestone, and particularly coal, which is the most important of our raw materials and of the most general interest.

IRON ORE

So far as iron ore is concerned, India is one of the richest countries in the world, being endowed by nature with very extensive deposits of very rich ore. The Singhbhum-Orissa field is the most extensive in India. The tonnage of this field has been estimated by Mr H. C. Jones of the Geological Survey, at 3,000 millions, and, if anything, it is probably an underestimate. Practically the whole of this ore is hematite, with an iron content of sixty to sixty-nine per cent.

COAL

While the position regarding iron ore is highly satisfactory, that regarding coal, particularly the coal required for the smelting of the iron ore, is far from satisfactory. Dr Fox has estimated the resources of Indian coal over four feet in thickness up to 2,000 feet in depth and twenty per cent. in ash at 24,000 million tons, of which coal of good quality up to 18 per cent. ash is 6,000 million tons, while coking coal suitable for metallurgical purposes is only 1,400 million tons. Coking coal in India is confined to the Gondwana coal beds of the Damodar Basin. On the existing methods of working coal the total life of the coking coals of India is estimated at about fifty years. This is a position which neither the Government nor those interested in the metallurgical industry can view with equanimity. The most recent Committee appointed by the Government of India to investigate the position and suggest remedies was the Burrows Committee of 1937. The terms of reference to that Committee were unfortunately not comprehensive enough and the legislative measures taken by Government as a result of the recommendations of the Committee are mainly confined to the ensuring of safety in Mines. The problem of Indian coking coals is, however, one of conservation as well as of safety and if proper attention is paid to conservation, the problem of safety will more or less automatically be solved. Legislation in the interest of safety which places additional burdens on the

industry without assisting it to dispose of its production in a more scientific manner, is likely to worsen the situation by hastening the uneconomic exploitation of the good coals by the smaller colliery owners. What is required is the rationalization of production as well as of consumption. In order to achieve the rationalization of consumption, a thorough chemical and physical survey of the coalfields beginning with the Jheria coalfield, in conjunction with a scheme of coal utilization research is absolutely necessary. For that purpose it is necessary to create a Fuel Research Board as a branch of the Board of Scientific and Industrial Research with a proper personnel, adequate staff and funds.

FUEL RESEARCH BOARD

Power is a *sine qua non* of the development of all industries and the proper conservation and utilization of the coal resources of the country is the first question that requires to be tackled in any consideration of the power resources of the country. The geological survey of the various coalfields has been excellently and exhaustively carried out at great expense to Government and it is high time that a scientific, chemical and physical survey were also carried out. Such a survey has been instituted in Great Britain and has resulted in a mass of most valuable information regarding British coals which has in many instances completely altered the attitude of the industry to many varieties of coal and enabled a more efficient use to be made of them.

On the production side the most important problem is that of the co-ordinated sequence of working the coal seams. Perhaps the worst feature of the working of Indian collieries is the exploitation of the richer coal from the lower seams for immediate profit and the neglect of the upper seams resulting in subsidences, fires and destruction of valuable coals. The co-ordinated sequence of working will prevent this destruction of top seams and will eliminate to a large extent the necessity of stowing altogether. No. 16 seam in the Jheria coalfield is a case in point. This coal has good coking properties but because of its high ash content and doubtful swelling tendencies it has been comparatively unexploited, either as a steam or coking coal.

The washing of coals is another question affecting production. In many cases the ash in the Jheria coals is inherent or when present in a free condition is of about the same specific gravity as the coal itself, thus making the separation impossible or difficult, but it has been proved that in certain of our high ash seams the ash content can be reduced by liquid flotation. 11 and 16 seams Jheria come into

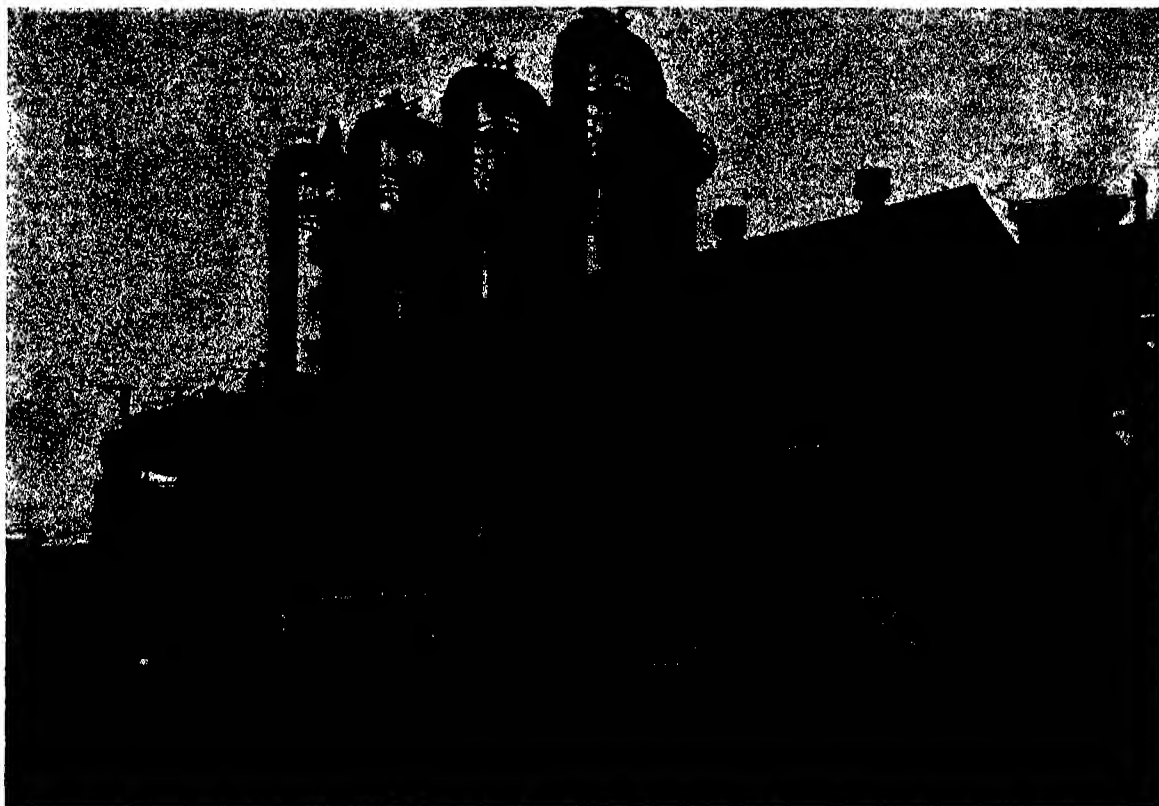
this category and further research is necessary to determine whether it is economically feasible to wash these coals with a view to reduce their ash content.

On the consumption side, the chemical and physical survey into our coal seams in conjunction with coal utilization research will in the first place enable us to determine the range and variety of coals suitable for coking as well as boiler purposes. Research is necessary in order to ascertain whether with proper blending and mixing the demands of the metallurgical industry need be confined to the very limited Jheria field. Several experiments have been carried out in the past, but further systematic research by the Board suggested above into blending with high ash coking coals, with swelling coking coals and with non-coking coals may result in the conservation of good coals and an extension of the range of coals available for metallurgical purposes.

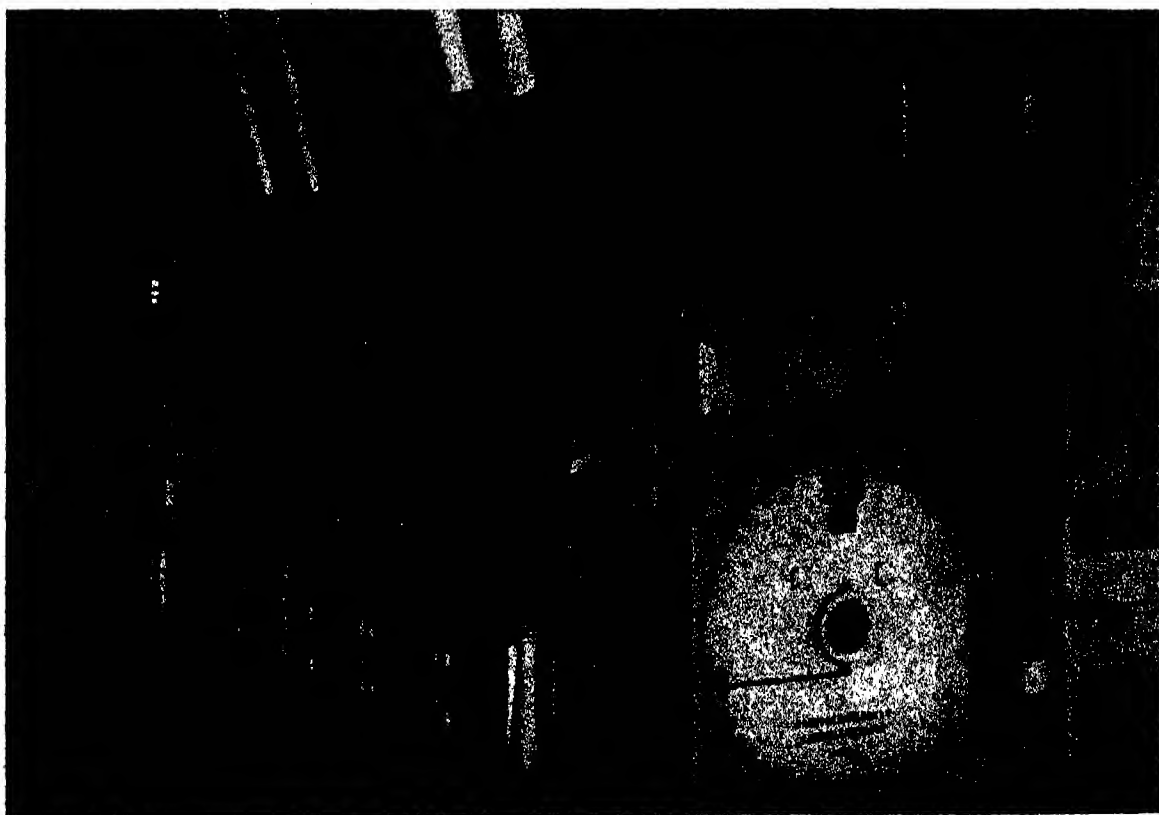
Similar research is also required in the case of power coals. A certain amount of information is already available but is mainly confined to the mixing of the high volatile coal in the Raneegunge field with the low volatile coal in the Jheria field for the export market and bunkering only. These low volatile coals from the Jheria are good metallurgical coals and research will doubtless produce suitable blends for export and power requirements without encroachment on these valuable low volatile coking coals.

The utilization of high ash coals for electrical generation at the sources of production and the distribution of the energy thus supplied over large areas is another problem of the first magnitude. The erection of a large power station on the coalfields for the distribution of cheap power to surrounding areas has already been advocated from many sources and has engaged the attention of the Government of Bihar. Further investigation of the suitability of the coal for such a purpose will help greatly towards the fulfilment of this very desirable project and should form one of the first objects of enquiry by the proposed Board.

Low temperature carbonization tests with various classes of coal, particularly of high ash, which are unsuitable for metallurgical purposes and also unsuitable on account of high ash content for transport to distant areas for power purposes, should provide another field for the activities of the Board. A number of scientists from the platform of this Congress as well as outside have advocated the cheap production of domestic coke on a mass scale and the utilization of the resultant tar for industrial purposes. The present very small production of soft coke is capable of very great extension if a market can be



NEW GAS CLEANING PLANT



NEW POWER PLANT

found for the coke as well as the resultant tar, even if the gases are ignored for the present. The economic difficulties in the way of such a proposal need not be minimized but practical experiments have already been carried out at Patna under the auspices of the Bihar Government and these would seem to indicate that further research may prove successful. Should this prove to be the case, there would be an adequate supply of raw material for the foundation of hydrogenation plants. This may be regarded as a distant aim as such plants have not proved too successful in other countries, but with the cheap Indian coals and the large quantities of tars which would be available from their low temperature carbonization success may be easier of attainment in India than in other countries.

The Board should also investigate the question of the scientific preparation of coal for the market and buying and selling on specification. This would mean the complete abandonment of the existing unscientific system of grading. The seams which were originally graded, have become exhausted or are nearing exhaustion or have deteriorated to such an extent that classification is in many cases no longer applicable. The disposal of the metalliferous production of the country has long been established on the international basis of scientific specification and it would be equitable to both buyer and seller alike to establish the buying and selling of coal and coke on a similar basis.

If my proposal for the establishment of a Fuel Research Board is approved, I would suggest that as the Jheria coalfield is practically the sole source of our coking coal and is also the centre of the Indian School of Mines, the headquarters of the Board should be situated at Dhanbad and the School of Mines and its laboratories which should be adequately equipped for the purpose, should be utilized for the investigations of the Board.

PROGRESS IN THE LAST DECADE

The last decade has seen a great expansion of the steel industry in India, accompanied by improvement in the various processes and the application of scientific methods of control. You will forgive me if I confine my remarks to the works of the Tata Iron and Steel Company alone, as the steel-making plant at Bhadravati in the Mysore State was put up in 1936 and has an annual capacity of about 20,000 tons only, while the plant of the Steel Corporation of Bengal with an estimated capacity of two hundred to two hundred and fifty thousand tons of finished steel, has begun operation very recently. In terms of tonnage, the progress can be

measured by the fact that while the Tata Iron and Steel Company produced 422,000 tons of finished steel in 1929-30, the corresponding production in 1939-40 was 777,000 tons. Ten years ago only thirty per cent. of the demand of the country for steel was met by the indigenous industry, whereas in 1939-40 about eighty-four per cent. of the demand was so met and the day is not distant when India will be able to supply not only the whole demand of the country except in a few very specialized directions but also to spare some steel for export.

COKE OVENS

Following the sequence of the manufacturing processes of steel, I begin with the coke ovens, where the coal is converted into coke. Ten years ago we had three batteries of Wilputte Coke Ovens and two batteries of the still older Koppers Coke Ovens which together produced 720,000 tons of coke, 22,300 tons of tar and 6,600 tons of ammonium sulphate. By 1940 all except one of the Wilputte batteries were replaced by three modern batteries of Simon-Carves Coke Ovens containing 54 to 55 ovens in each battery at a cost of Rupees one crore and sixty-five lakhs. These batteries are of the twinflue 'Underjet' type capable of carbonizing 1,300 to 1,500 tons of coal each per working day. Arrangements have been provided for firing the ovens with coke oven gas or with the cheaper blast furnace cleaned gas. Firing the coke ovens with blast furnace gas releases the more valuable coke oven gas for use in steel making furnaces in other parts of the plant. The twinflue construction assures a more uniform heating throughout the length and height of the oven with a resulting uniformity of the coke produced. As stated in the preceding part of the address, all coals do not give good coke and careful investigations have to be carried out in the blending and mixing of different varieties of coal. To this end three large slot bunkers of the capacity of 2,000 tons each have been installed. Coal wagons, as they arrive from the collieries, are taken over to the selected bunkers and unloaded. The coal is then mixed mechanically in the required proportions from the three bunkers and suitable mixed coal is conveyed by mechanical conveyors to the ovens into which it is charged.

The three principal by-products of the coke ovens are coke oven gas, ammonia which is turned into ammonium sulphate and tar. The sulphuric acid for the manufacture of the ammonium sulphate is made in a recently installed contact process plant producing fifty tons of 100% acid per day.

So far the manufacture of benzol as a by-product of the coke ovens has only been attempted on a very

small scale in India. A plant is now nearing completion at Jamshedpur for the manufacture of benzol and toluole for the Government of India. When it comes into operation, it will be of great assistance in the manufacture of high explosives for the ordnance factories. The plant is designed for extracting benzol motor spirit and toluole and is being installed by Messrs. Simon-Carves.

BLAST FURNACES

The next stage in the manufacturing process is the blast furnace for the production of pig iron. Ten years ago, Jamshedpur had four blast furnaces; two of the capacity of 900 tons, one of 750 tons and one of 250 tons per day. The small blast furnace was completely rebuilt in 1936 and its capacity was increased to 550 tons. An entirely modern blast furnace was installed last year. The diameter of its hearth is 22 feet 6 inches, of the bosh 26 feet 6 inches and of the top 19 feet. Its height is 95 feet and volume 35,160 cubic feet. For the one year that this furnace has been in operation it is estimated to have produced more iron than has ever been produced elsewhere on a furnace of similar size over a similar period. The total pig iron capacity of the Jamshedpur plant is a million and a quarter tons per annum.

For every ton of iron made, a blast furnace produces roughly 100,000 cubic feet of gas. This blast furnace gas contains about 14 grains of dust per cubic foot of gas at N.T.P. This gas has considerable fuel value, but owing to its dirty condition its use in industrial plants, such as blast furnace stoves and boilers is restricted. It has been realized that considerable fuel economy can be effected if this gas is cleaned. In the last ten years the Steel Company has installed two large gas cleaning plants, each with a capacity of fourteen million cubic feet of blast furnace gas at N.T.P. per hour. Both the plants clean the gas to a purity of 0.008 grains of solids per cubic foot of gas at N.T.P. The older of these two plants is the Lodge Cottrell plant of the dry type which came into operation in 1934. The second gas cleaning plant is of the Brassert design. This plant consists of wooden-hurdle wet washers which not only cool the dirty blast furnace gas but also remove about eighty per cent. of the solids from the gas. This semi-cleaned gas is then passed through the Cottrell wet electric precipitators which precipitate the rest of the solids and deliver clean gas to specification.

FUEL ECONOMY

The old concepts of fuel economy and energy distribution have been completely revolutionized by the modern scientific use of coke oven and blast

furnace gases. Fuel economy and distribution of energy in a large plant like that of the Tata Iron and Steel Company is a highly specialized job, which is in charge of a special department of the plant, designated the Energy and Economy Department. The efforts of this department have succeeded in reducing the overall fuel rate from 3.56 tons of coal per ton of steel in 1930-31 to 2.19 tons in 1939-40. Modern practice aims at reducing the use of coal as fuel and replacing it by the more efficient by-product fuels, such as coke oven gas, blast furnace gas, coke dust, etc. The use of mixed gases in this connection requires special mention.

The cleaning of the blast furnace gas permits of its use in coke ovens and releases a corresponding amount of the richer coke oven gas for use elsewhere at the plant. Blast furnace gas has a comparatively low heating value of about 110 B. T. U. per cubic foot of gas, while coke oven gas has a value of about 470 B. T. U. per cubic foot. Modern practice tends to a greater use of coke oven gas or a mixture of coke oven and cleaned blast furnace gas in steel making and re-heating furnaces, replacing to that extent coal which has been used so far in the form of producer gas. Fuel costs are thus greatly reduced. For the successful use of the gases it is necessary to have steady pressure of gas at the consuming ends. For that purpose two large dry gas holders for the storage of blast furnace and coke oven gas respectively have recently been installed. These gas holders act as reservoirs which smooth out the fluctuations of the gas caused by the furnace irregularities and thus assure continuous operations of boilers, coke ovens and other consuming centres. The blast furnace gas holder is a huge structure 283 feet high, 176 feet in diameter, capable of holding 5½ million cubic feet of gas at N.T.P. The coke oven gas holder is 192 feet high, 112 feet in diameter and holds 1½ million cubic feet of coke oven gas.

STEEL-MAKING PRACTICE

The last ten years have also seen important developments in steel-making practice and a considerable increase in production.

Steel-making operations at Jamshedpur are carried out in two types of plants, the Open Hearth and the Duplex. The Open Hearth is the oldest part of the Jamshedpur plant. Four out of the seven furnaces which we were working ten years ago, have been remodelled along modern lines and an eighth furnace has been built. The ingot production from this plant has been increased during the last ten years by over 100,000 tons per year, the figure for

1929-30 being 242,000 tons as compared with 345,000 tons in 1939-40. The Duplex steel-making process, as its name implies, consists of two operations, (a) blowing the molten pig iron in acid lined Bessemer Converters to remove the silicon and manganese and most of the carbon, and (b) transferring the blown metal to basic-lined Open Hearth tilting furnaces where the phosphorus is removed and the steel finished to chemical specification. Improvements to this plant during the last ten years have resulted in increase of production from 340,000 tons in 1929-30 to 670,000 tons in 1939-40. In addition to these two steel-making plants a four-ton electric furnace was installed in 1936 mainly for the manufacture of electric castings, while two five-ton electric furnaces have only recently been installed and are being utilized for the manufacture of class steel, spring steel and alloy steel. The installation of these electric furnaces has been of the greatest assistance in the making of superior quality alloy steel required by the Defence Department.

A NEW STEEL-MAKING PROCESS

The most important advance made during the last decade, from the point of view of scientific research, is the practical development of the rapid dephosphorizing process. As this matter has never been the subject of public discussion in India so far, a few details will not be out of place here. As is well known, Indian pig iron contains about 3 to 4% phosphorus. This percentage of phosphorus in the iron neither lends itself to the straight basic Bessemer process nor to the straight acid Bessemer process. The phosphorus has to be removed to 0.05% for most commercial specifications though as much as 10% is admissible in certain products. The removal of this phosphorus is normally effected by the action of basic and oxidizing slags in Open Hearth furnaces. At the best of times this is a slow operation taking from one to several hours even in the quick working Open Hearth furnaces of our Duplex plant. In 1935, when our general manager, Mr Ghandy, and myself were on leave in Europe, our attention was drawn to certain developments in France, where a French steel engineer, M. Perrin, had carried out successful experiments in the rapid deoxidation of steel by violent mixing together of slag and steel so as to obtain a considerably greater area of contact between them than could ever be obtained in the conventional Open Hearth furnaces. This idea of the violent mixing of slag and steel was also considered applicable to the dephosphorizing operation. After a study of the French experiments, large-scale investigation over a long period was carried out at Jamshedpur and ultimately a practical

method was evolved for operating the dephosphorizing process on a commercial scale under Indian conditions. This new process consists in blowing molten pig iron in an acid Bessemer Converter to remove all the silicon and manganese and as much of the carbon as required. This blown metal is then poured from a considerable height into a synthetic molten basic oxidizing slag contained in a ladle. The metal comes into very intimate contact with the slag and the phosphorus is rapidly removed in the course of two or three minutes, instead of as many hours, in the normal open hearth process. As the steel and slag separate, the steel is finished to analysis and cast into ingots. The process is subject to exact control and steel of basic Bessemer quality can be made directly from the pig iron. Moreover, the dephosphorized metal can be further treated in an Acid Open Hearth furnace and steel of first class open hearth quality can be made. Thus for the first time in India it becomes possible to make acid steel out of Indian basic pig iron. A plant for the manufacture of steel by this process is now under construction. The successful development of this process may be regarded as the most important advance in steel making practice that the young Indian steel industry has made. It is likely to have far-reaching effects on the establishment of several new industries in India, such as locomotive manufacture and the manufacture of railway wheels, tyres and axles for which acid steel is specified.

RAILS

In the manufacture of rails, advance has been made as a result of metallurgical research during the last ten years. Investigations have shown that medium manganese rails with a lower carbon and higher manganese content of 1.10 to 1.40% have superior properties of wear and resistance as compared to straight carbon rails with higher carbon and lower manganese content. There is a growing tendency to replace straight carbon rails with medium manganese rails. On the other hand, high chromium rails were found unsatisfactory.

An interesting advance has been the installation of Sandberg Ovens for the Sandberg controlled cooling process for rails. All over the world the controlled cooling of rails has come to be looked upon as a definite and desirable advance on the old practice of cooling rails on open hot-beds. The Tata Iron and Steel Company have obtained exclusive rights in India for the working of the Sandberg process. They have installed four Sandberg Ovens for the controlled cooling of their rails. Experiments are also being conducted in the welding of rails in the track. This aims at giving longer lengths in the

track between joints and helps to provide a smoother ride.

PLATES

In the Plate Mill, the most interesting development in the last decade is the installation of a modern normalizing furnace for plates. This furnace was first installed to normalize some of the high tensile steel plates for the new Howrah Bridge. By the aid of this furnace it is now possible to produce in India normalized plates which had formerly to be imported. The furnace is also used to normalize certain structural sections. Thus materials with a new range of physical properties have been made available to the designing engineers. It is worth noting that Indian plates have largely replaced foreign plates even for the most exacting demands, such as for barges and ships.

SHEETS

Ten years ago, the Sheet Mill at Jamshedpur consisted of five hand-operated units and the total annual production was 38,000 tons. The rolling of sheets was an extremely strenuous manual operation calling for considerable physical exertion. Production was low, defects and rejections were high. Today we have only four hand-operated mills and three mechanized units with an output of 170,000 tons. These new mechanized units have produced tonnages which, as far as can be ascertained, constitute a world record for this type of equipment. Besides the ordinary quality mild steel sheets, the Jamshedpur plant now turns out different classes of sheets with a high grade finish, including 'Tiscor' and high carbon sheets. Panel plates for coach building are supplied to the Railways and the various engineering firms. Other special developments in sheet manufacture are the rolling of drum stock for the manufacture of drums and containers, enamelling stock for deep-drawing and subsequent enamelling, furniture stock and, lastly, special sheets for steel helmets for the army.

LOW-ALLOY STEELS

It is owing to applied research that most of the significant advances in the steel industry at Jamshedpur during the last decade have been made possible. I have already mentioned the case of the rapid dephosphorizing steel. The development of low-alloy steels is another very important instance. Engineers in general and transportation engineers in particular are beginning to realize that ordinary carbon steel performs its functions only at the expense of unnecessary dead weight and ex-

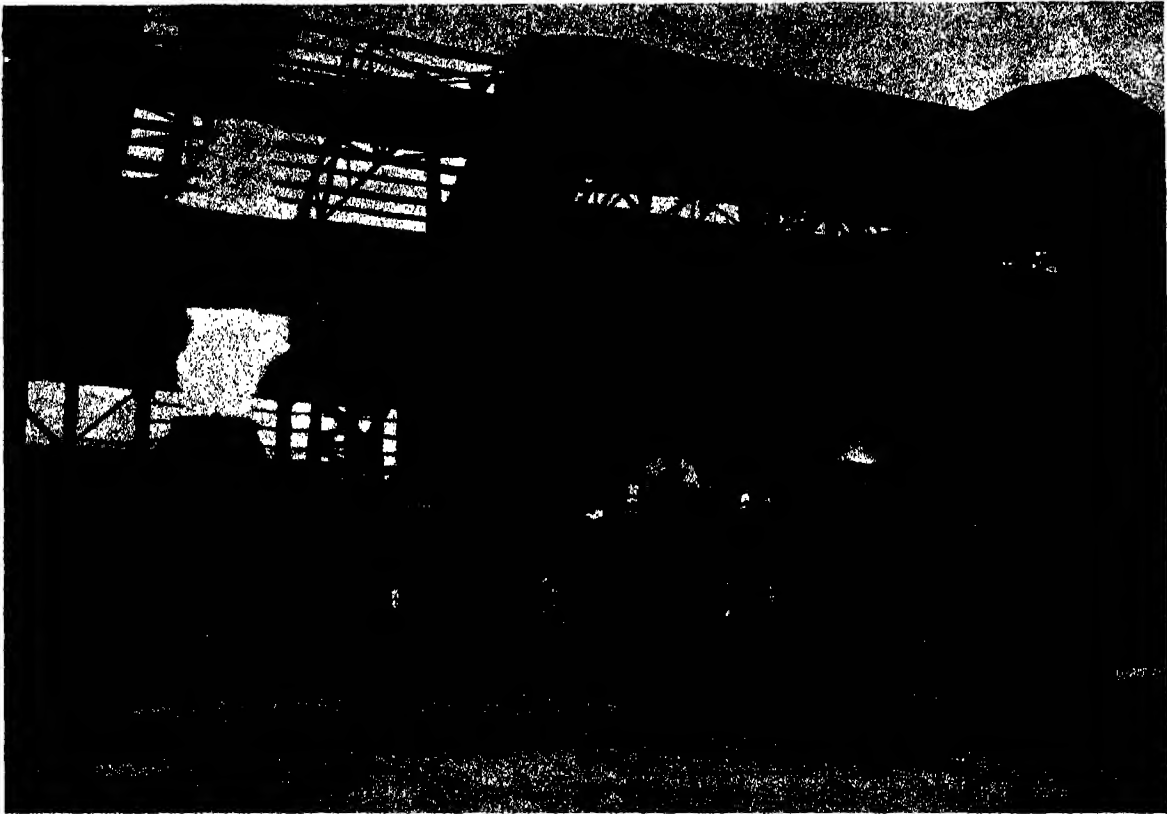
cessive loss due to its low resistance to corrosion and abrasion. The problem of providing suitable materials for lighter weight is not one relating to mechanical strength alone. It requires the integration of several properties in one material, such as strength, resistance to impact, corrosion and abrasion, ease of forming, satisfactory welding, etc., as well as moderate cost. With this end in view, metallurgical research was conducted at Jamshedpur, resulting in the development and commercial manufacture of a low alloy, high-tensile steel containing copper and chromium known as 'Tiscrom'. This steel is being employed in the construction of the new Howrah Bridge.

The introduction to India of another low-alloy high-tensile steel, sold in America under the trade name 'Corten' deserves mention. Research conducted in America had shown that the addition of a high percentage of silicon and phosphorus to alloy steel, containing chromium and copper, resulted in a low-alloy high-tensile steel of the same properties as those of Tiscrom but with the additional important property that it could be readily welded by all methods of rapid welding such as oxyacetylene and automatic electric welding. After an investigation into the possibilities of the manufacture of this steel in India and an examination of the claims put forward for it, the Tata Iron and Steel Company obtained exclusive rights for the manufacture and marketing of this steel in India under the trade name of 'Tiscor'.

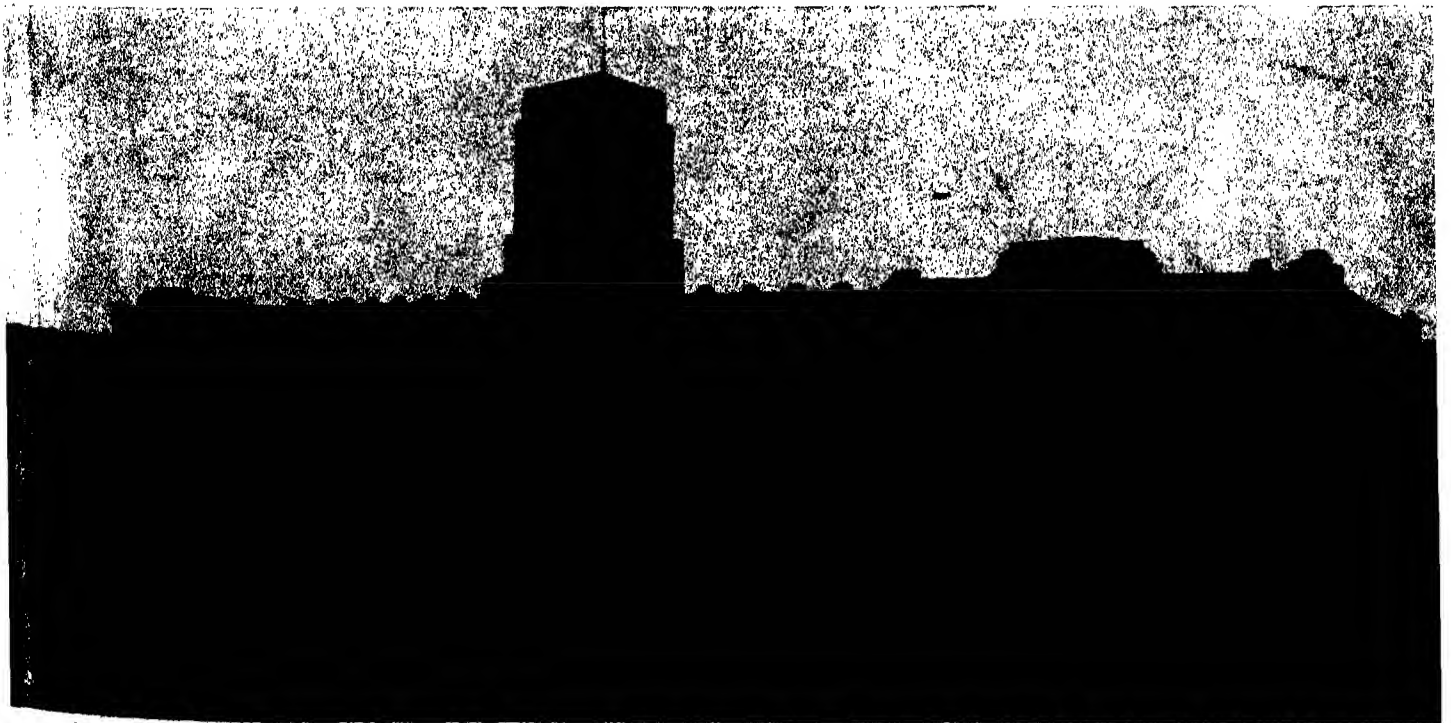
SPECIAL STEELS

Reference has already been made to the installation of the electric furnaces. Among the special qualities of iron and steel manufactured from these furnaces are chrome-manganese steel for crane track wheels, thirteen per cent manganese steel for crusher jaws and similar hard wearing parts of machinery, nickel-chrome heat-resisting steel and cast iron for various castings required to withstand high temperatures and nickel-chrome-molybdenum steel for crane pinions, mill rolls, etc. The manufacture at Jamshedpur of special alloy steel rolls has enabled the Steel Company to replace similar rolls of foreign manufacture.

Since the outbreak of the war, intensive research work has been undertaken for Government in connection with the manufacture of armoured vehicles in India, and as a result a bullet-proof armour plate of special alloy steel which has stood the firing tests and has been accepted by Government has been developed. Suitable steels for the manufacture of armour piercing shot and for steel helmets have also



BESSEMER CONVERTERS



NEW CONTROL AND RESEARCH LABORATORY

been produced. Research work was undertaken at the instance of Government in regard to the supply of steel suitable for telegraph wires. This steel has now been successfully manufactured and the wire rolled at the works of the Indian Steel and Wire Products out of this material has met with the approval of the Department of Posts and Telegraphs.

Researches are being carried out on behalf of the Defence Department in connection with the welding of chrome-molybdenum steel plates for aircraft manufacture and in other directions.

Most of the high speed steel requirements of the plant for machine tools are now being met by the remelting of tool scrap in the high frequency induction furnace in our laboratories. High chrome and stainless steels have been produced in the furnace in small quantities.

Besides metallurgical research, fuel research, chemical research and research in refractories are being pursued. Researches of the fuel department in blending and mixing have resulted in the determination of the most suitable varieties of coals for coking and similar purposes. Research on refractories has enabled us to evolve a better class of refractories for the use of the steel plant. Indian raw magnesite was at one time considered unsuitable for use in basic steel furnaces. Investigations carried out at Jamshedpur have now made it possible to produce in India the Steel Company's entire requirements of finished magnesite. Metal-cased magnesite bricks made at Jamshedpur have given very encouraging results for the superstructure of basic furnaces. Chrome magnesite brick for use above the slag line in basic Open Hearth furnaces in place of silica brick is another

important development in the refractory field. Other interesting developments in brick manufacture are investigations into the possibilities of the manufacture of forsterite, semisilica, micaschist and mullite bricks. An entirely new process has been developed for the manufacture of mullite refractories using cyanite, sillimanite and andalusite, India having practically a monopoly of the first two. Very productive work has also been accomplished with regard to high-temperature mortars. Superior types of mortars for high temperature work are now being locally made, replacing many of the imported brands.

A NUCLEUS FOR A NATIONAL METALLURGICAL LABORATORY

To facilitate research work, a modern well-equipped laboratory was erected in 1937 at a cost of over rupees ten lakhs. May I express the hope that with the facilities for metallurgical research provided by this laboratory and its workers, Jamshedpur may in the near future become the centre of a National Metallurgical Laboratory and Research Institute and thus be enabled to play a greater and worthier part in the development of the metallurgical industry in India.

When the titanic conflict now being waged ends, as end it must, in the triumph of the democracies and the cause of human freedom, I pray that India may emerge from it with the foundations of its industrial as well as political freedom well and truly laid, so that she may be properly equipped to play her rightful part in peace and in war as a worthy member of this great commonwealth of nations.

BENARES

The Site of the Science Congress, 1941

*Its History and Present Sights**

PART I

History of the Growth and Development of the City

THE City of Benares to which the Indian Science Congress returns in its second round after 18 years is by common consent regarded as the most sacred city for the Hindu inhabitants of India. Sacredness carries with it the idea of antiquity. We can therefore just take a bird's eye-view of the ancient history of this famous city.

Benares certainly flourished as a city when Rome did not exist and Athens was a mere Pelasgic village (before 900 B.C.), but we have no material proof as yet whether it is as old as Memphis or Thebes of the Egyptians or Ur of the Chaldees, and even in India as old as Mahenjo-daro and Harappa in the Indus valley. The oldest material records as yet do not go beyond the Maurya age (the pillar of Asoka stands at Sarnath which was a part of old Benares). When we scan the Hindu scriptures, we find that neither the city nor the country round was regarded "holy" in the most ancient times in the eyes of the Vedic Aryans. The name of Benares is not found in the *Rigveda*. We come across a reference to Kasi, in the Pippalada version of the *Atharvaveda*, but this is anything but complimentary. The writer of the verse describes a magic process which is invoked to drive away the fever of patients, apparently of the north-western country where Aryan culture first flourished, to the land of the Kasis and Magadhas. This has been interpreted to mean that at the time when the verse was written, Benares and the other eastern parts of India had not accepted the sacrificial cult of the Vedic Aryans. Even in the *Mahabharata* (in

its modern form, a product of the third or fourth century B.C.) Benares is given a very scanty notice amongst the holy places of India. Its reputation grew with the eastern migration of holiness which we trace from the first century A.D. with the rise of Pauranic Hinduism.

Though, therefore, the sacredness of Benares seems to be a rather late idea, it is quite probable that even in pre-Vedic times it was the seat of a vast population and a place of commercial, political and religious importance. Several confused legends in the later literature have been interpreted to mean that the cult of the Siva-Pashupati for which Benares has been celebrated throughout ages, had been flourishing there, even before the advent of the Vedic Aryans. The existence of this cult has been established in the pre-Vedic civilisation of the Indus valley (c. 2600 B.C.), traces of which have been found as far east as Ruper in the Ambala district. It is quite possible that even about 3000 B.C., Benares was a flourishing centre of this cult. Prof. Altekar thinks that Benares resisted for long the inroads of the Vedic sacrificial cult and the memory of these conflicts is preserved in the Puranas in the form of the well-known story of Daksha Prajapati, who invited all the Vedic gods to his sacrifice but excluded Siva from it. The Puranas record that on account of this insult Daksha's sacrifice was wrecked by the votaries of Siva and he lost his life, and later, the Vedic gods were compelled to agree to the inclusion of Siva amongst them; this admitted Siva to the advantages of the sacrificial cult.

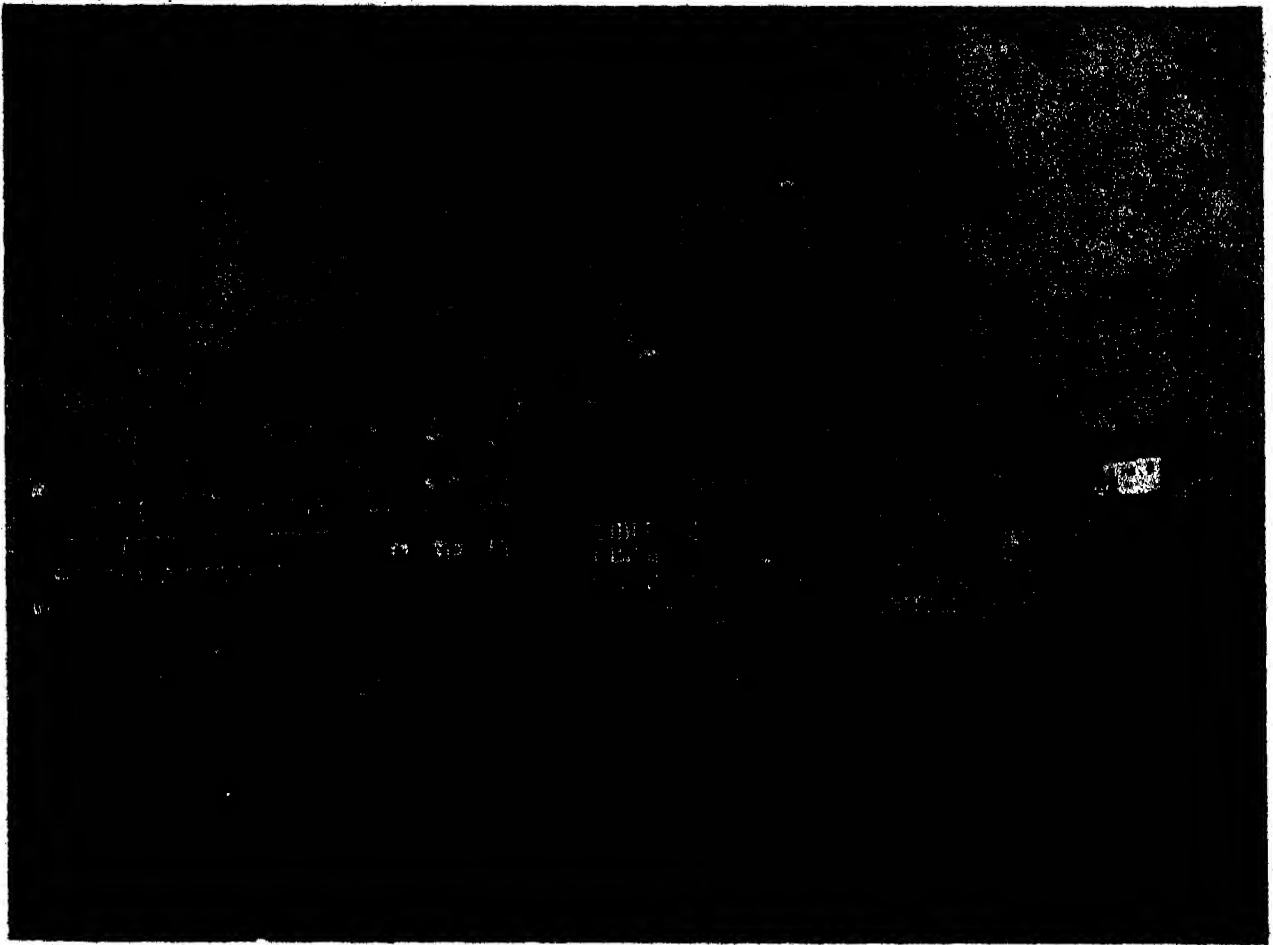
The same story is probably recorded in another form in the story of Divodasa who is regarded as a later descendant of Kāśī, the eponymous hero who is credited in the Puranas to have founded Benares. Divodasa, a strict votary of Siva is said to have banished the gods (Vedic gods) from Benares but ultimately came to terms with them and left the city after leaving a phallus of Siva to be worshipped there.

* In preparing this account, we acknowledge with gratitude that the first part has been based on Prof. A. S. Altekar's book, *History of Benares* and the second part has been adapted from an article with illustrations kindly supplied to us by Prof. P. S. Varma. We are also indebted to Rai Bahadur Ramaprasad Chahda for going through the article and helping us with many facts and suggestions.
—Ed., *Science and Culture*.

It is recorded also in the Puranas that the descendants of Divodasa were involved in a long struggle with the Haihayas from the Nerbudda valley, as a result of which they abandoned the city and founded a new Benares 15 miles away at the confluence of the Gumti and the Ganges.

In Upanishadic times Benares was regarded as a great centre of Brahnavidya, the cult of the Brahma or the Universal Soul, which for a time is supposed to have acquired the alternative name of Brahnavardhan. King Ajatasatru of Benares vicd

the name of the country was derived. The name of the capital is supposed to be derived from the two streams, Varuna and Asi which bounded the city on the north and the south. Varuna exists under this name even today, but 'Asi' appears to be a pure invention, though the name is applied to a dried up ditch in the south; but some water should be pumped into it, if it is to be called a stream. In fact, the origin of the name appears to be obscure. The Kasis, as the name of a people, and the river Varanavati are named in the *Atharvaveda*. But the city,



BENARES FROM THE GANGES

with the king Janaka of Videha and tried to attract the expounders of the Upanishadic philosophy to his court by giving them presents and offering other allurements.

Benares is equally famous in the Buddhistic literature. According to the Jataka stories, a line of kings bearing the epithet of Brahmadatta reigned there. The country roundabout Benares was peopled by a Kshatriya tribe called the Kasis from which

Varanasi (Benares) is not mentioned in any text older than the earliest Buddhist texts, according to which Gautama Buddha visited it on his way to Mrigadava, modern Saranath. According to the *Vinaya Pitaka*, his first disciples after the five old pupils to whom he preached his first sermon at Saranath came from the city of Benares. This is not to be wondered at. It is stated in the *Satapatha Brahmana* (13, 5, 4, 23), "Satanika Satrajita per-

formed the Govinata (form of Asvamedha), after taking away the horse of the Kasya (King); and since that time the Kasis do not keep up the (sacrificial) fires, saying that the Soma-drink has been taken from us". The *Satapatha Brahmana* may be assigned to eighth century B.C. The extract shows that the land of the Kasis had ceased to be a centre of Brahmanic orthodoxy even before Gautama Buddha. Heterodoxy of the people of Benares at so early an age may be due to the rise of Pasupata. Of the primitive form of Saivism which is condemned in the Brahmanic texts, the discovery of what seem to be phallic emblems and figures of seals sitting in yoga posture that look like the prototype of Siva indicates that some form of Saivism may be very old and a wave of that cult might have reached Benares even before Gautama Buddha and *Satapatha Brahmana*. This hypothesis explains the pre-eminent place that Benares occupies among the Saiva holy places.



GOLDEN TEMPLE OF BENARES

Benares was an ancient centre of trade. Katyayana, the author of a supplement to the grammar of Panini in one of his stanzas (on Panini 4, 3, 84) refers to Benares by the name of Jitvari, city of triumph (Katyayana is assigned to an age not later than third century B.C.). Patanjali in his *Mahabhashya* explains that the merchants called

Varanasi Jitvari (evidently because they found trade in the city very profitable).

Kasi appears to have formed a powerful kingdom some centuries before the rise of Magadha. There used to be constant war between the two neighbouring kingdoms of Kasi and Kosala (modern Oudh), and it is said that some years before the birth of Buddha, Benares was conquered by the king of Kosala and was absorbed as an integral part of his kingdom.

During Buddhistic times Benares enjoyed the reputation of being a great centre of learning, second only to Taxila in northwestern India. The reputation of the city was so great that when Buddha first thought of his system he could find no better place for expounding it than Benares. He met his first five disciples at Sarnath, which is six miles to the north of present Benares, and must have formed part of old Benares. The ancient name is alternatively Rishipattan or the abode of sages and Mrigadava, or "the deer park of king Brahmadatta". The place where Buddha first turned the Wheel of Law forms the present ruins of Sarnath. Here Asoke erected one of his pillars and built the famous temple of the Wheel of Law, round which the huge monastery of Sarnath grew up in subsequent times. Many of the first disciples of Buddha were drawn from the city of Benares. At the time when the Chinese traveller Yuan Chwang visited Benares (630 A.D.), Sarnath was a huge Buddhist establishment with a monk population of 1,500. No educational activities are however referred to. The ruins of Sarnath have been carefully excavated by the Archaeological Survey of the Government of India, and the finds are housed in a Museum on the site. Pious Buddhists, under the stimulus of the late Ceylonese leader, Anagarika Dharmapala, have erected a fine new 'Vihar' on the eastern side of Sarnath and has given to it the ancient name of 'Mulgandhakuti Vihar'. A visit to Sarnath is well worth the trouble.

Benares passed afterwards under the rule of Magadha. It used to be the seat of a province and Sisunaga, the founder of the Sisunaga dynasty, is said to have been first a governor of Benares. Never a capital city, it must have shared in the political vicissitudes of the times, connected with the dynasties of the Mauryas, the Sungas, the Kanvas who ruled Northern India from the fourth century B.C. to the first century B.C., but no memories of the city during these times have been preserved. Sunga remains have however been found in several old mounds in the vicinity of Benares.

It was during the last quarter of the 1st century A.D. that Benares first fell under the rule of a

foreigner but one who rapidly became a good Indian. Inscriptions have been found at Sarnath—and they can still be seen in its museum, which show that Kanishka, the great Kushana emperor, had succeeded in conquering the whole of U. P. right up to and including Benares, some time before 81 A.D. In that year Kshatrap Vanashpara was the governor over Benares and Kharapallana was the viceroy over the province. Both these officers were foreigners, as their names clearly show.

BENARES DURING PAURANIC TIMES

The Kushana rule over Benares does not seem to have lasted for more than a century ; for, towards end of the second century A.D. the Kushanas lost their control over all the territories outside the Punjab. Nothing definite is known about the political history of Benares during the third century A.D. It is presumed that just before the rise of the Guptas, Benares passed under the Bharasiva emperor Pravarsena, who celebrated ten "horse-sacrifices" at Benares. Some are of opinion that the Ghat known as the 'Dasaswamedaghat' marks the site of these sacrifices. In the fourth century A.D. Benares formed part of the Gupta empire. One of the first specimens of Gupta sculpture was discovered at Benares some years ago. It is a very big image of Krishna holding up Gobardhan and is now deposited in the Sarnath Museum. The Gupta rule lasted for about two centuries and was followed by that of the Maukharis, who ruled over the city from Kanauj for about a century. During the first half of the seventh century A.D., Benares was included in the kingdom of the famous king Harsha.

With the disappearance of Harsha from the political scene, the history of U. P. and Benares becomes obscure. Yasovarman of Kanauj seems to have ruled over Benares for some time towards the middle of the eighth century. After the fall of Yasovarman (732 A.D.) Benares shared in the political turmoil of Northern India, passing successively under the Palas of Bengal (800 A.D.), the Pratiharas of Kanauj (850-1030 A.D.), and the Chedis of Jubbulpur. In 1026 A.D. the Bengal king, Mahipala, carried out repairs to Sarnath temples. According to the Sarnath inscription of king Mahipala, he is credited to have built a number of temples at Benares. The Chedi king Karna is said to have built a temple at Benares known as the Karna Meru.

It was during the rule of the Chedi king Gangeyadeva (1015-1041) that Benares first suffered from Muslim invasion. Mahmud of Ghazni could not penetrate as far as Benares, but Ahmad Nialtagin, a general of his son and successor, Masud, managed

to launch a surprise attack on the city in 1033 A.D. and plundered the city but was driven back very quickly.

BENARES UNDER THE GAHADWALS OF KANAUJ

The disappearance of the Chedi power at about 1060 A.D. led to anarchy in the United Provinces for nearly a quarter of a century. It was put an end to by king Chandradeva, the founder of the Gahadwal dynasty, about 1080 A.D. Being the favourite place of its rulers, probably their second capital, Benares prospered immensely during the 12th century. The area of the Benares Fort to the north of the Kasi station was the centre of administration at this time. During the diggings recently carried out by the E. I. Railway for the purpose of getting earth to fill new station platforms, a number of antiquities of the Gahadwal period were found near Rajghat. Had the excavation work been scientifically carried out, it would have thrown much light over the history of Benares during the 11th and 12th century A.D. The Archaeological Survey took charge of the site only when earth to the depth of



QUEEN'S COLLEGE AT BENARES

18 feet was already removed by the Railway over an area of about eight acres. Excavations carried by it in October and November, 1940 have unearthed a number of structures of the Gupta and the Kushana periods, and a large number of seals of ministers, district officers and temples.

The prosperity of Benares came to an end with the Gahadwal rule. The last king of this dynasty, Jayachandra, was overthrown by Muhammad Ghori in 1193 and one of his generals, Kutub-ud-din Aibak attacked and plundered Benares in 1194. Muslim historians tell us that a thousand temples of Benares were razed to the ground and mosques were built in their places. 1400 camels were required to carry away the plunder from the city.

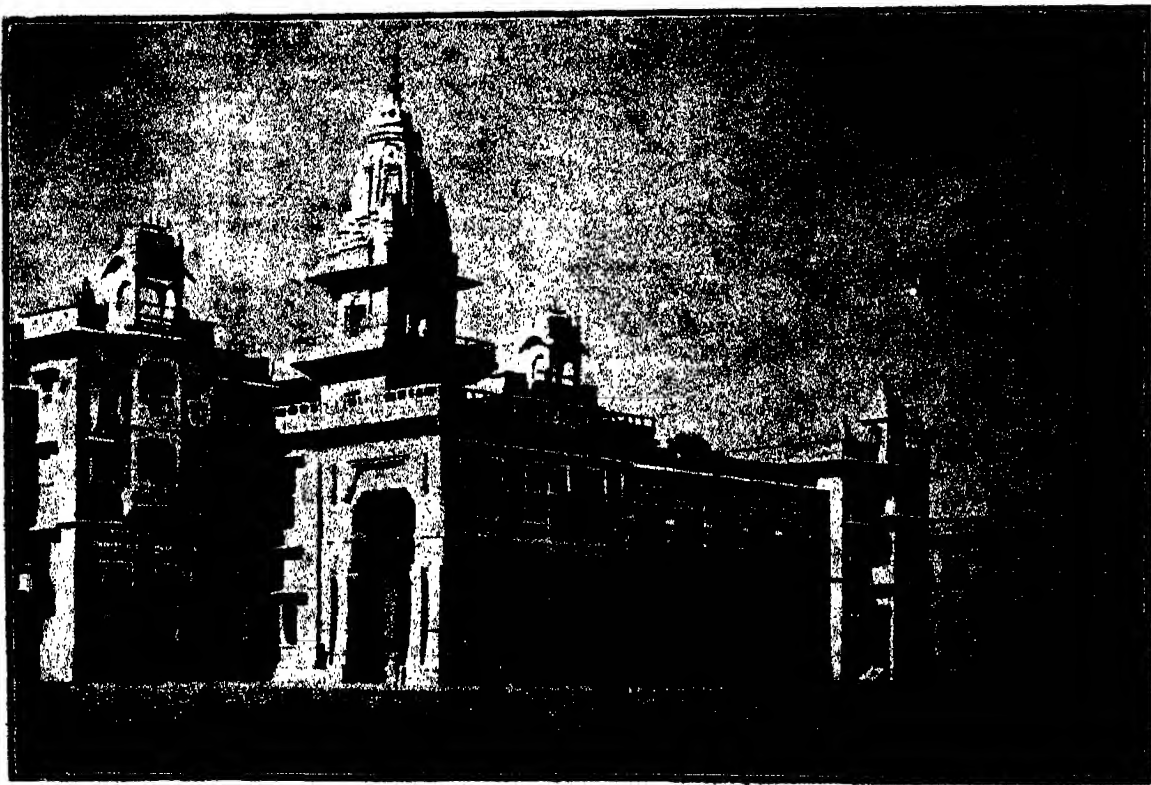
BENARES AS A CENTRE OF LEARNING AND RELIGION

Buddhist centres of learning like Nalanda and Valabhi bore a great resemblance to modern universities. They were organised corporate bodies, following definite courses of education and being governed and managed by executive committees presided over by distinguished monk scholars. Hindu Benares was not such a centre of learning. There were no organised colleges or universities there, which were governed by central bodies and used to teach courses that were approved by any central body like senate or board of studies. It was a centre of learning, simply because there were among its residents a large number of famous scholars

known as *Kasika* in the seventh century A.D. It is the earliest extant commentary on Panini.

In ancient times, religion and learning went hand in hand ; Benares became a great centre of learning primarily because it was a great centre of religion. We have seen already how it was a notable centre of religion, and philosophy in the Upanishadic period. Its Mahadeva worship goes back to even a greater antiquity. Its Visvanatha probably represents a happy synthesis of the Mahadeva of the Vedic times and the presiding deity of Benares of the pre-Vedic religion.

The main temple of Benares has been referred to by the Chinese traveller Yuan Chwang, who had



HINDU UNIVERSITY ARTS COLLEGE

who were giving free tuition as a matter of sacred duty, to such earnest students, as might come to them. The reputation of Benares as the foremost centre of Sanskrit learning continued undiminished during the Muslim rule also. In the provinces no Pandit was heard with respect, unless he had spent a dozen years at Benares. One of the most notable literary work produced at Benares is the commentary on the grammar of Panini by Bana and Jayaditya

visited the city in c. 640 A.D. It was a grand structure, with a spire of more than 100 feet height. There seems to have been an image of Siva in the human form in the temple, perhaps in addition to the linga. Benares as the holiest place is referred to in hundreds of inscriptions from South India belonging to the first millennium A.D. It must have been visited by thousands of pilgrims in those days as it is today.

BENARES AS AN INDUSTRIAL CITY

Benares however owed its importance not only to its being a centre of religion and learning ; it was also a great commercial and industrial city. Even in pre-Buddhist times Benares was famous for its soft and thin muslins, bewitching perfumes and scented oils. Throughout the length and the breadth of the country, the Benares silks were then, as now, famous for their texture, colour and intrinsic merit, and were used by the fashionable circles of Sindh as well as Bengal, Kashmir as well as Madras. A lady, anxious to dissuade her husband from his resolution to renounce the world is seen promising to him,—

‘I’ll wear finest Benares robes for thee,
With crimsoned sandalwood perfumed’.

Benares used to export huge quantities of silks, perfumes and scented oils to all the provinces of the country. Caravans carrying on this trade were always to be seen encamped on its outskirts. In these days Benares was famous for its ivory work as well. Later on from about the third century A.D. it developed an important school of sculpture. Benares images were well known for their beauty and excellence, and were exported to distant cities. The image industry still exists in the modern city, but its workers have now lost the old skill and tradition.

BENARES DURING MUHAMMADAN TIMES

Let us now pass on to consider the political history of the city during the middle ages. The importance and prosperity of the city declined during the Muslim rule. Partly because it was the centre of idolatry and partly because it lay off the then recognised road to the east which passed through Kanauj, Ayodhya, Jaunpur and Ghazipur, Benares did not remain the headquarters of a provincial government during the Muslim rule. It was the headquarters of merely a district. Under the Moghul rule for some time it was a mint city, but it never became the headquarters of a Suba or province.

The Muslim rule with its alien culture and iconoclastic attitude naturally caused a great shock to the city. During the 13th century there seems to have been wholesale exodus of the Pandits from the city to the Deccan because none of the present Brahmin families of Benares can trace their descent to the receivers of the gifts recorded in the copper plate inscriptions of the Gahadwal kings but this soon came to an end, for the Deccan itself passed under the Muslim rule in the fourteenth century.

During the Muslim rule, the temples of Benares were demolished several times. Kutub-du-din razed to the ground a thousand temples in the city. There is reason to believe that a similar course was followed by Alaud-din Khilji and Ibrahim Lodi. During the Sharqui rule (1400 A.D.—1470 A.D.), temples in the city were once more pulled down in order to supply building material for the beautiful mosques that were being built at Jaunpur, the capital of the Sharquis. There is still an inscribed stone in the north-western corner of the Lal Darwaza mosque at Jaunpur, which shows that it originally belonged to the Padmesvara temple of Benares, which was built near the temple of Visvanatha in 1296 A.D.

BENARES UNDER THE FIRST MUGHAL RULERS

With the advent of Akbar, things changed for the better. The emperor had decided to follow a policy of toleration towards his non-Muslim subjects, and it now became possible for the Hindus to openly build new and grand temples and ghats in the city. It was during Akbar's rule, that Raja Man Singh of Amber built Manmandir and Mansarovara. The temple of Visvanatha was also rebuilt on a grand scale in c. 1580 by Raja Todar Mall, the finance minister of Akbar, at the instance of Narayana Bhatta, who was the *agrapandita* of the city. During the reign of Shah Jehan, the imperial policy changed and the rebuilding of temples was prohibited. 76 temples that were under construction in Benares were destroyed. Aurangzeb's iconoclastic zeal was greater than that of his father. He issued a special and specific order that the great temple of Visvanatha, which was the holiest object to the Hindus, should be demolished and a mosque built in its place. The order was executed during the monsoon of 1669 A.D. The Gyan Vapi mosque to the north of the present Visvanatha temple was the site of the older temple. A glance at its rear wall will show that the structure was originally a Hindu temple. The old walls have been kept intact to a considerable height and have been surmounted by the Muslim domes. The doors of the old temple can also be clearly seen in the back wall, filled up with stones.

The fate of the Visvanatha temple was shared by almost all the shrines in the city. It is a significant fact that modern Benares has no temple which can be definitely assigned to the pre-Aurangzeb period.

Though the days of royal patronage were gone for ever Benares continued to be the centre of Sanskrit learning and Hindu religion during

Muslim rule as well. Its attraction to the Hindu mind continued to be as powerful as ever, and we find that several families of the Deccanese (from Maharastra, the Karnatik and Telingana, and from Bengal) Pandits came and settled down there during the sixteenth century A.D. These families were occupying a very prominent place in the intellectual life of Benares for more than three centuries. A very large number of Sanskrit works were written in Benares during the period 1500 to 1800, dealing with Dharmasastra, logic and Vedanta. The contribution of Benares to Sanskrit scholarship and literature was greater than that of the whole of the rest of India. Amongst the famous scholars may be mentioned Bhattoji Dixit, who wrote *Siddhanta Koumudi*, the most famous commentary of Panini's grammar. Benares was fortunate to receive royal patronage during the time when Dara Shikoh was the governor of Allahabad. This prince had a fascination for Hindu philosophy and engaged 150 Benares Pandits to translate the Upanishads into Persian. It was the Latin rendering of this Persian translation that first acquainted the western scholars with the philosophy of India.

four saint poets, who made the city a centre of the medieval Bhakti movement. Both Guru Nanak and Chaitanya, the leaders of the Bhakti schools of the Punjab and Bengal respectively, visited Benares in order to expound their gospel in this famous centre of Hindu religion and culture.

BENARES IN EARLY BRITISH TIMES

Benares practically passed under Hindu rule again, when Mansaram, the founder of the present ruling family of Benares, got the management of its *Zemindari* from the Nabob of Oudh in c. 1725. Eventually however Benares passed under the British sphere of influence in 1765 and East India Company supported Balwant Singh who succeeded Mansaram in his struggle against the Nabobs. Balwant Singh died in 1770 and there arose a dispute about succession between Mahip Narain Singh, his daughter's son and heir, and Chet Singh his illegitimate son. The former was a minor and so Chet Singh could manage to get his claim recognised both by the British and the Nabob. Soon however there



UNIVERSITY COLLEGE OF ELECTRICAL AND MECHANICAL ENGINEERING

BENARES AND THE BHAKTI CULT

The contribution of Benares to the development of the medieval Bhakti school is also great. Ramananda, one of the earliest Vaishnava reformers, flourished in Benares during the 14th century; he used to live near the Panchagangaghat. During the next century lived his two disciples Kabir and Raidas; of these the former was born within the city area of Benares and his *samadhi* has given the name to the Kabir Choura Mohalla of the city. Kabir was followed by Tulsidas, the famous author of the *Ramacharitamanasa*, who carried on his literary and religious activities in Benares till his death in 1623. Benares may well be proud of these

arose the well-known dispute between Chet Singh and Warren Hastings and the latter came to Benares to settle it in July 1781. Hastings' headquarters were in Madhodas' Garden in Kabir Choura ward, which still exists.

Chet Singh became very nervous when the Governor-General himself came down to Benares. He proceeded to explain his position. He offered Hastings a personal bribe of Rs. 2½ lakhs and the Company a fine of Rs. 20 lakhs. But Hastings was relentless. He demanded 50 lakhs, which Chet Singh could not pay. He was therefore put under arrest in the Sivala fort, where he was staying in the city. Two companies of soldiers were sent to guard him there.

MARATHAS AND BENARES

When the news of Chet Singh's arrest reached his troops across the river at Ramnagar, they came to Benares and besieged the English troops. The Ramnagar army was able to kill all the British officers and most of their sepoy before Major Popham could reach them with reinforcement. Flushed with their earlier success, Chet Singh's soldiers drove back Major Popham also. While these skirmishes were going on outside the Sivala fort, Chet Singh managed to descend down to the river through one of the windows of the fort by means of turbans tied together; he then crossed over to Ramnagar. The place from where Chet Singh effected his escape is still known as Chet Singh Ghat, and is pointed out to the visitor by the boatmen, when they take him to show the Ghats.

When Major Popham was defeated by Chet Singh's troops, Hastings's position became very precarious in Benares and he also followed Chet Singh, and thought that discretion was the better part of valour. On one dark night he stealthily left the city and managed to reach the fort of Chunar by a forced march. Hastings' flight from Benares is remembered in the popular doggerel :

हासीपर हाबदा बोड़पर जीन ।

अलुदि याव अलुदि याव मोयारेन हेष्टिन ॥

From Chunar he made better arrangements to reduce Chet Singh and was eventually successful. Chet Singh fled away to Mahadji Scindia and Hastings put Mahip Narain Singh, the minor grandson of Baiwant Singh, on the Benares throne. The young and inexperienced ruler was cleverly induced to surrender his ruling powers in 1794 and Benares thus became a mere Zemindari and passed under British administration.

Mahip Narain Singh and his descendants continued to be real Zemindars and nominal Rajas for more than a century. In 1910 Lord Minto's Government took the unusual step of creating a new Indian State by investing Maharaja Prabhu Narain Singh, the then Maharaja of Benares, with full ruling powers over his Zemindari. The new Benares State, that was thus created, was not however given jurisdiction over the city of Benares, which continues to be under British administration. Its capital is at Ramnagar, which is opposite to Benares on the other bank of the Ganges. H. H. Maharaja Prabhu Narain Singh died in 1932 and was succeeded by his son H. H. Maharaja Aditya Narayan Singh. The latter died after a short reign of seven years in 1939 and has been succeeded by his adopted son, H. H. Maharaja Vibhuti Narain Singh, who is at present a minor.

It was the ambition of several Peshwas and their generals to conquer Benares and rebuild the Visvanatha temple on its old site. When the Marathas decided to help the Nabob of Oudh against the Rohilas one of the conditions on which the help was given was that the Nabob would surrender the holy places of Mathura, Prayag, Kashi and Gaya to the Marathas. The Marathas were able to defeat the Rohilas for the Nabob, but their engagements elsewhere left them no time to compel their ally to cede to them the above cities as was agreed upon. In the meanwhile Benares passed under the British suzerainty, and so the Maratha plan failed.

Though the Marathas could not rescue Benares from the Muslim rule, their rise to political power and importance contributed very largely to the prosperity of the city during the 18th century. Modern Benares is largely a creation of the Marathas. Its present Visvanatha temple has been built by Rani Ahilyabai of Indore in 1777. The present temples of Annapurna, Kalabhairava, Sakshivinayaka, and Trilochanesvara have also been built by the Maratha chiefs and generals. A large number of the ghat, e.g., Amritraoghat, Ahilyaghat, Scindiaghat, Bhonslaghat, etc., have also been built by the Marathas.

Only a few incidents worth noting here have occurred in the history of the city during the British period. A deposed Nabob of Oudh, Wazir Ali, by name, (not to be confused with Wazir Ali Shah, the ruler of Oudh, who was deposed in 1857), was staying in the city; he raised an insurrection in 1797 when the English tried to remove him to Calcutta. During this trouble, the resident of Benares was killed by Wazir Ali. The latter was however soon overpowered and deported to Vellore.

A terrible Hindu-Muslim riot broke out in the city in October, 1809 when a temple of Hanuman was sought to be built on the ground between the temple of Visvanatha and the mosque of Aurangzeb. Law and order could be restored only after several days. In 1857 the tactlessness of the British officers drove the Indian regiments in Benares to rebellion; but the sepoy were unable to capture the city. The city remained quiet, but punitive expeditions had to be sent to some of the neighbouring villages. Permanent gallows were erected in the city to overawe the population. Benares authorities were mainly concerned in guarding the Grand Trunk Road and hurrying reinforcements to the north and the west. The city assumed the appearance of a vast military camp.

PART II

Description of Modern Benares

BATHING GHATS

THE religious character of the city of Benares is best epitomised in its picturesque river fronts. A visitor views from the river a long procession of sacred ghats, architectural temples and palaces that rise tier above tier from the water's edge from Asi Sangam down to the Dufferin bridge. The ghats which decorate the bank of the Ganges and are held in highest sanctity and great popularity number about forty. The five principal ones visited by all pilgrims when reckoned from the south are (i) the Asi Sangam, (ii) Dasaswamedh, (iii) Manikarnika, (iv) Panch ganga, and (v) Baruna Sangam (the confluence of the Baruna river with the Ganges).

The Asighat is at the junction of the Ganges and the so-called Asi-stream. It is a bathing place without a stairway. Below Asighat is the Tulsighat so-called after the celebrated Tulsidas. Next to the Tulsighat in importance is the Shivalaghat above which is a fortress in which Raja Chet Singh used to reside till his rebellion in 1781. Next to Shivalaghat comes the Harishchandraghat associated with the legend of the king of the same name of the *Satyayuga*.

Dasaswamedhghat is the most frequented one by the people, specially during the eclipse when thousands of visitors and pilgrims crowd on the broad steps of the ghats. It is supposed in popular fancy to be the scene of the celebration of ten-horse sacrifices by Grandfather Brahma but more probably as mentioned before it marks the site of the celebration of these sacrifices by Emperor Pravarsena of the Bharsivas about 300 A.D. Within a furlong from here comes the Manmandirghat constructed in 1693 by Raja Jaya Singh of Jaipur. The gigantic astronomical instruments in the Manmandir are similar to those erected by the same prince at Delhi, Muttra, Ujjain and Jaipur. Not far from it is the Manikarnikaghat, the name derived from the well in which the earring of Durga is said to have dropped. The place is regarded as the holiest cremation ground in India.

Then passing over some small ghats the visitor comes to the great Panchgangaghat, being one of the sacred places of Benares. Five rivers, four being invisible to the mortal eyes, are supposed to meet here. Again passing over some unimportant ghats, such as the Sitlaghat, Lalghat and Gaighat, one comes to the Trilochanghat, named after the three-eyed Shiva. This is practically the last ghat before

one reaches the Rajghat, where stood the old Rajghat fort of great antiquity and as noted before a recent excavation has raised many rare and important antiquities.

TEMPLES AND MOSQUES

Taking up the temples from the northern part of the city, we come across the Adikesab temple containing the image of Vishnu at the Baruna Sangam. Next comes the temple of Bhaironath, containing the image of Bhaironath, the divine *Kotwal* or chief of police under Visvanath. The temple was built by Baji Rao, the Peshwa of Poona. At a short distance to the east of this is the Navagraha temple, dedicated to the moon and the other Hindu planets. Beyond this is the temple of Dandpan, the huge stone truncheon with which Bhaironath chastises offenders. In the neighbourhood is the Kalkup, the Well of Fate, to which pilgrims resort at midday when failure to see one's shadow in the water signifies an inevitable death within six months.

In the central area of the city are the temples of Adi Biseswar, Visvanath and Annapurna. The Adi Biseswar temple is situated to the northwest of the Carmichael Library and is supposed to be the most ancient of all the Benares shrines.

In front of the lofty mosque of Aurangzeb standing to the south of the Carmichael Library is the Jnankup, the Well of Knowledge, into which the second Visvanath image was consigned during the iconoclastic activities of Aurangzeb. Close by the courtyard of this well is the famous temple of Visvanath. This comparatively modern temple is noted for its dome and tower covered with plates of gilt copper out of the gift of Maharaja Ranjit Singh of the Punjab. Not far from the Visvanath temple stands the temple of Annapurna, the goddess whose name means a "Storehouse of food". This temple was built by Peshwa Baji Rao about 1721. At a short distance from this is the deity Ganesh under the title of Sakshi Vinayak.

In the western area of the city near Ausanganj is the ancient temple of Bara Ganesh containing a huge red figure with silver hands and feet, which is said to be the largest image of the elephant god in existence. In the quarter of Chetganj is a large tank called Pisachmochan, named after a demon, called Pisach, from whom the city was delivered by Bhaironath and all pilgrims are enjoined to visit the place before proceeding to more holy shrines.

In the southern area of the city are the Jain temple, situated just to the east of the waterworks and marks the birth place of Parsvanath, one of the

most famous of the Jain Tirthankars. The Durga temple and the Durgakunda are situated at the southern end of the city. The original shrine was built at the time of King Mahipal of the Pala dynasty, and the present building was erected by Rani Bhavani, the famous princess of Bengal. The Lolaraka kund is a tank, near the pumping station, whose water is supposed to remove the barrenness of women.

MODERN BUILDINGS

Of the large number of modern buildings the following stand out unrivalled for architecture or for educational and technical importance. The Nandeswar Palace is surrounded by an extensive garden and is the town residence of the Maharaja of Benares reserved for distinguished visitors and high officials. It has some historical importance being the residence of Mr Davis, the magistrate who in 1799 gallantly defended himself with a few sepoy against the followers of Wazir Ali, the deposed king of Oudh. The Queen's College including the Government

established by Annie Besant. Near the Theosophical Society stands the old Central Hindu College which formed the nucleus of Benares Hindu University.

The latest modern building of importance is the Bharat Mata Mandir situated on the Vidyapith Road inside of which there is a wonderful relief map of India, wrought in white marble and executed with highest precision in respect of measurements and geographical details. On the walls are painted maps of India of the different historical periods.

EDUCATION IN PRESENT-DAY BENARES

There are in all about 60 Sanskrit *pathshalas* which are officially recognised and aided by the department of education in the province. Nearly 200 teachers impart instruction to about 2,500 scholars in Veda, Vyakaran, Sahitya, Nyaya, Vedant, Mimansa, Sankhya, Yoga, Dharmashastras, Jyotish, Itihas-Puran, etc. Besides these recognized institutions there are many *Tols* conducted through the private efforts of learned Pandits.



VIEW OF BENARES HINDU UNIVERSITY HOSTELS

Sanskrit College is the second oldest college established in India dating from 1791. It is constructed in a finely curved Gothic style. "It is considered the finest Gothic building in Asia and has been aptly described as appearing like a perfect dew drop settled down from the heavens". The Saraswati Bhavan is situated to the north east of the Queen's College and is a modern building built in the ancient Indian style. It houses a large oriental library and a very rare collection of Sanskrit manuscripts. The Nagari Pracharini Sabha is the Hindi academy established some forty years ago for Hindi culture and publication. Connected with it is the Bharat Kala Bhavan, a museum of art and archaeology established through the zeal of Rai Krishnadas.

In the western part of the city are the Ramkrishna Mission Buildings, the Theosophical Society,

While Benares still maintains the spirit of all that is best in eastern culture and civilisation, it contains some of the most progressive educational institutions based on western model. The oldest amongst these is the Jai Narain High School, founded in 1814 by Maharaja Jai Narain Ghosal Bahadur. Its control was subsequently transferred to the Church Missionary Society. In 1845 a college department was added to the school, the college being affiliated to Calcutta University. At present it is a high school only under the control of the Church Mission and is aided by the U. P. Government

Chronologically the Queen's College is slightly older than the Jai Narain High School. It continued to be a good first grade college affiliated first to the Calcutta University and subsequently to Allahabad

University till 1921 when the status of the college was reduced to the intermediate stage.

Another educational institution, which was started in the pre-Mutiny days in 1854, is the Bengali Tola High School to meet the educational requirements of the local Indian community. It is termed "Bengali" because it is situated in one of the most ancient quarters of the city, "Bengali Tola". Soon after the Mutiny the well-known Hindi poet and dramatist Bhartendu Harishchandra founded the school which is now named after him. It has recently been raised to the status of an intermediate college and is affiliated to the Board of High School and Intermediate Education, Allahabad.

With a view to removing the drawbacks of the western system of education, the late Dr Annie Besant founded in 1898 the Central Hindu College and its collegiate school. It attracted a noble band of ardent and selfless workers and soon became an important institution for the "education of Hindu youths in their ancestral faith and true loyalty and patriotism". Both the college and school soon became famous. In 1913 the management of these institutions passed on to the Hindu University Society to form the nucleus of Benares Hindu University. The present building is occupied by the Central Hindu School only, which is the biggest of all the schools in Benares and is certainly one of the biggest high schools in India. Attached to this school is also a separate school for girls called Central Hindu Girls' School affiliated to Benares Hindu University. Almost about the same time, the Anglo-Bengali School was started by the genius and industry of Babu Chintamani Mukerjee. It grew steadily in popularity as a high school and was affiliated in 1938 for the intermediate examination both in arts and science by the Board of High School and Intermediate Education, U. P.

The Udai Pratap College and Hewett Kshatriya High School owe their foundation and continued existence entirely to the foresight and philanthropy of Raja Udai Pratap Singh, a big Talukdar of Oudh. Both the school and the college are residential and admission is confined to Kshatriya boys only.

Benares being one of the most important places of pilgrimage, it has naturally attracted many missionary societies to start their denominational schools. The Christian missions maintain a number of institutions, some of them being especially reserved for girls. The Wesleyan and American Mission maintain a high school, an industrial school, and a training school for primary teachers. The Church Mission maintains a Normal School for the training of women. Then the Arya Vidya Sabha,

representing the Arya Samaj, maintains the Dayanand Anglo-Vedic College, the Nityananda Sanskrit Veda Pathshala, and a primary school for girls. The orthodox Hindus also maintain a few institutions of the modern type. The best amongst them are the Sanatan Dharma High School and the Gurjar Pathshala. The Indian section of the Theosophical Society runs a residential educational school in its beautiful compound at Kamacha. There are three institutions run by the Rishi Valley Trust where formal religious teaching however no longer forms an integral part of the educational curriculum. Two of these institutions are situated in the outskirts of the city near Rajghat and the third called the Vasant College for women is within the city.

Benares Hindu University

BENARES HINDU UNIVERSITY has grown as almost another city by itself to the extreme south of Benares. It is situated opposite Ramnagar. Within hailing distance of the asram said to be sanctified by the illustrious sage, Vyasa, the lofty buildings of the University raise their heads to the sky inviting all seekers of truth to its hospitable halls of learning. The rise and growth of this remarkable institution is due to the selfless and patriotic efforts of the great Indian leader, Pandit Madan Mohan Malaviya. Services towards its development have been rendered by the late Sir Sunderlal, the late Maharajadhiraj of Darbhanga and the late Dr Annie Besant.

The campus of Benares Hindu University is one of the largest of university campuses in the world and extends in the form of a semicircle of two square miles in area facing the Ganges. The foundation stone of the University was laid in 1916 by His Excellency Lord Hardinge and the University moved to the new buildings in July 1921.

The Colleges are all situated on the diameter of the semicircle, the boarding houses of the University are in a row just behind them, the numerous playgrounds stretching between them. On the circumference, there are residences of the members of the staff. It is hardly necessary to stress that the building plans of the University have not yet been completed and among the structures yet to be built when sufficient financial support is forthcoming for the purpose, are the Senate House, the Museum and some laboratories and colleges.

As the visitor enters the University grounds from the city, there are the Women's College and the Women's Hostel of the University which have been built from a generous endowment provided for the

purpose by the Khattau brothers of Bombay. There are already a few hundreds of girl students in the University and their number is increasing so rapidly that it is not possible to provide more seats in the hostel. Alternative subjects in the curricula specially suitable for women students, such as domestic science, music and painting are attracting a good number of girl students.

The other building in the neighbourhood is Sir Sunderlal Hospital which provides medical treatment to the large number of students and the staff of the University living on the grounds. One wing is devoted to the Allopathic system and the other wing to the Ayurvedic one. The Ayurvedic College of the University is also situated in the same building. Almost opposite is the extensive Ayurvedic garden in which plants and drugs used in Ayurveda are grown. Then we come to the Vice-Chancellor's lodge at present occupied by Pandit Madan Mohan Malaviya. Adjacent to it are the two guest houses, the first one being called 'Cochin Guest House' and the second one 'Lachhman Guest House', the latter being at present occupied by the Pro-Vice-Chancellor of the University. A few yards more and we come to a crossing from where spreads a long vista of rooms accommodating a thousand students in three blocks of hostels. The first one is shared by the students of the Central Hindu College, the College of Science, the Ayurvedic College, the Colleges of Oriental Learning and Theology. The department of music is also there, so also the residential accommodation for members of the University staff in charge of the inmates. This pile accommodates four hundred students, and though not so comfortable as the other hostels, goes a long way to help in the relief of congestion in the hostels.

The next two hostels, each with a magnificent sweep of about a furlong in length, are of the same type accommodating about three hundred students in single-seated rooms of the students of the Central Hindu College, the College of Science and the College of Technology. The hostels are divided into six blocks each with a resident member of the staff acting as assistant warden for each block and living on the top floor in intimate contact with the students. All the amenities of hostel-life are there: the necessary kitchens, dining and store rooms, common rooms for meetings, reading and indoor recreation rooms, a dispensary and medical offices—all that is calculated to enrich residential life in a university.

On the same road farther away are three hostels built on somewhat different style accommodating about four hundred students of the Engineering College, the department of mining and metallurgy

and the departments of glass technology and pharmaceuticals.

Benares Hindu University has always been intended to be a unitary and residential University and it is only want of funds that has prevented provision of hostel accommodation for all students of the University who number nearly four thousand excluding those in the school department in the city. Besides the thousand students living in the six hostels, there are about 2 to 3 hundred students residing in private houses in the neighbouring villages recognised by the University.

The road leading to the right from the crossing near the Lachhman Guest House brings the visitors to the residences of the professors of the University of whom a large number live on the grounds. The residences are situated on two roads on which fine teak wood trees, Mahua and Jamun trees are planted. The University Posts and Telegraph Offices and the University Club, the centre of much social life, are also situated along the same line.

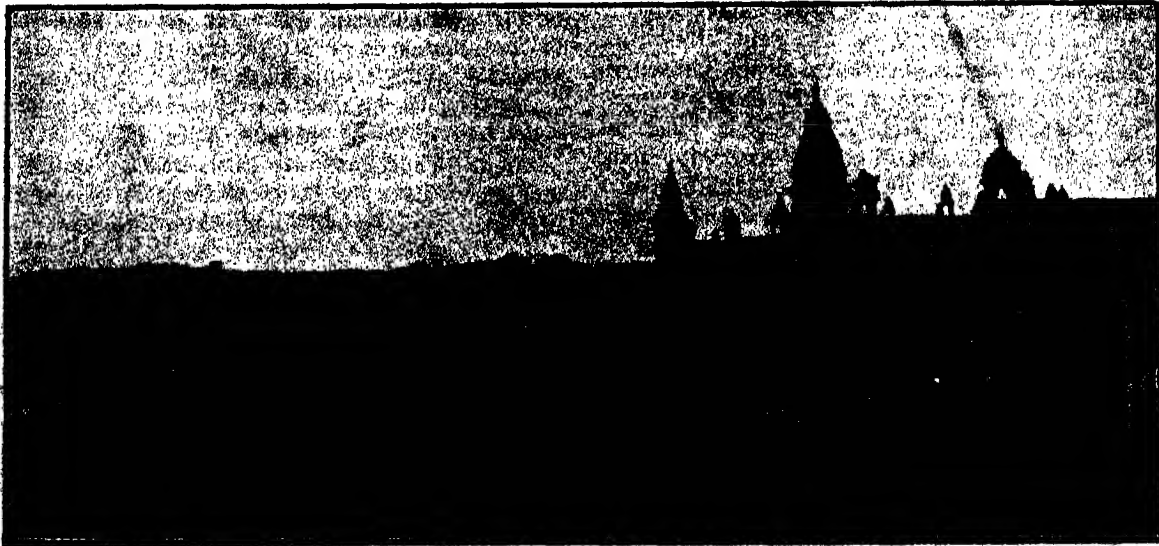
Turning to the left, we pass the Botanical Garden of the University. Reaching the diameter of the semi-circle, we have the college buildings and the laboratories along the line and facing them is an amphitheatre built on the occasion of the visit of His Royal Highness the Prince of Wales (later His Majesty George VI). This provides accommodation for thousands of spectators for matches and other functions of the University. Then comes the Arts College, called Hindu College, accommodating the departments of English, Sanskrit, philosophy, Indian languages, mathematics, history, politics, economics, commerce, besides the University offices, the office of the Registrar, the Law College and the Colleges of Oriental Learning and Theology, the last three colleges being held in the morning and evening hours. This and the two neighbouring buildings as also the other structures in the University, are all in the Hindu style of architecture surmounted with towers reminiscent of temples and faced with ornamentation of well-known Hindu symbols. They are all constructed of Chunar stone, brick and plaster, and constitute a remarkably fine set of buildings aspiring to fulfil Ruskin's ideal that "public buildings should be built to last and built to be lovely, as rich and full of pleasantness as may be, within and without". One of the attractions of the Arts College is its fine central hall serving as the meeting place for the University, pending the construction of the Senate House.

The next two buildings belong to the College of Science and house the finely equipped laboratories. Though originally meant only for physics and chemistry, they have had to accommodate several

sister branches of science. Physics has extended its hospitality to zoology and botany, each of which has a separate wing for itself on the upper floor of the second building while the third includes besides chemistry proper, the departments of mining and metallurgy, geology, and applied chemistry. Extensive halls for practical work accommodating a large number of students, special research rooms for advanced students and members of the staff, lecture theatres, all combine to rank the two among the finest and most comprehensive laboratory buildings of India.

Patiala, the institution has made great progress and has won reputation for itself in the educational world of India. Its workshops aim at giving an up-to-date and comprehensive training on the practical side to the large number of students on its roll while its power station furnishes them with excellent facilities for training in electrical engineering besides lighting up the hostels and other buildings of the University.

Beyond is the ceramics section of the College of Technology where instructions up to the B.Sc.



HINDU UNIVERSITY SCIENCE COLLEGE

Beyond this is the fine Library building, finest of all the buildings of the University, built by the magnificent donation of the Gaekwad of Baroda, called the Sir Sayaji Rao Gaekwad Library. It has several sections and contains a fine collection of about one lakh volumes. Next to it is the Institute of Agricultural Research which specialises at present in post-graduate instruction and research in the subject of agricultural botany and prepares agricultural graduates and graduates in science with botany for the degree of master of science. It also takes research students preparing for the degree of doctor of science in agricultural botany.

A little farther away is the College of Electrical and Mechanical Engineering which attracts students from all over India, from Burma and the Frontier Province, from Assam and distant Travancore. Founded with the help of a generous contribution of five lakhs of rupees from H. H. the Maharaja of

stage are imparted in the subject of ceramics. Adjacent to it is the department of glass technology in which teaching up to the M.Sc. stage is imparted to the students. In the same compound is the department of pharmaceuticals which gives B. Pharm. degree to its students. All these three departments have for the first time been taken up in India by Benares Hindu University. The last building on the road is Benares Hindu University Press which has very recently been started to meet the needs of the University and in a very short time it has become self-supporting.

Most of the collegiate institutions of the University have been mentioned. Reference however has yet to be made to the 'Teachers' Training College which is in the city near the Central Hindu School where the students acquire practical training supplementing the instruction in theory they receive at the college.

Short Life Sketches

of the

General President and Sectional Presidents

ARDESHIR DALAL

General President

Sir Ardeshir Dalal was born in 1884 and educated at Elphinstone College, Bombay, and St. John's College, Cambridge. He entered the Indian Civil Service in 1909, having stood first in the examination that year. After a few years in the districts as assistant collector; superintendent, land records, and collector, he became successively deputy secretary to the Government of Bombay, Revenue Department, acting secretary to the Government of Bombay, Finance Department, and acting secretary to the Government of India in the Education, Health and Land Departments. He was appointed municipal commissioner of Bombay in 1928 and in that capacity carried out many important reforms, notably the fight against malaria, to which in a large measure the City owes its present comparative immunity from that scourge. He retired from the Indian Civil Service in 1931.



Sir Ardeshir Dalal was member of the Bombay Legislative Council during 1924-26 and of the Legislative Assembly at Simla in 1927.

He is a director and partner of Messrs. Tata Sons. He is the director-in-charge of the Tata Iron & Steel Company and a director of several other joint stock companies connected with Tatas as well as the Associated Cement Companies and the Central Bank of India.

Under his guidance from 1931 the Tata Iron & Steel Company has grown from strength to strength. He has effected many notable improvements in the conditions of labour at Jamshedpur and has been responsible for the introduction of the profit-sharing scheme for its labour by the Tata Iron & Steel Company. This is the first scheme of its kind in India and certainly the most important.

He was the chairman of the Indian Chamber of Commerce, Calcutta, in 1938 and was knighted in 1939.

M. R. SIDDIQUI

President, Mathematics and Statistics Section

Born in Hyderabad (Deccan) in the year 1906, Professor M. Raziuddin Siddiqi graduated in mathematics from Osmania University in 1925. He completed the mathematical tripos of Cambridge in 1928. Thereafter he worked successively in Berlin, Göttingen and Leipzig till 1930 obtaining his doctorate from the last named University. He studied in Paris for another year and since 1931 he has been acting as a professor of mathematics in Osmania University. Besides scientific papers he has a number of books on mathematics,



He is a fellow of the National Institute of Sciences, Indian Academy of Science, National

Academy of Sciences, Cambridge Philosophical Society, Société Mathématique de France, etc., and vice-president of the Calcutta Mathematical Society. In 1936 he was awarded the Education Minister's gold medal by the National Academy of Sciences.

P. N. GHOSH

President, Physics Section

Professor Phanindra Nath Ghosh was born in February, 1884. He obtained his M.A. in 1908, Ph.D. in 1920, Sc.D. (*honoris causa*), of the University of Padua (Italy) in 1922. He was educated at the Presidency College, Calcutta, where he came



in close contact with Sir Jagadish Chunder Bose. Later he worked on electrical engineering practice under Dr P. J. Bruhl who was then professor of electrical engineering at the Bengal Engineering College, Sibpur. He joined Calcutta University as assistant professor of physics in 1916 when the University College of Science was founded and was appointed Ghose

professor of applied physics in 1920. He was deputed by Calcutta University to study different methods adopted in England in the continental universities for teaching engineering sciences, especially electrical engineering. During his tour in Europe he was associated with the firm of Siemens Schukert and Siemens & Halske at Berlin having worked in their factory and in outdoor undertakings. He worked for some time in the Berlin Technische Hochschule under Prof. Schlesinger, in the design and construction of modern machine tools. He also studied practical optics and testing of optical instruments at Zeiss works at Jena. He also worked in the National Physical Laboratory, England, on precision methods of measurements and of standardisation of electrical and mechanical instruments, and at the Bureau International Poids

et Mesures at Severs under the direction of Dr Guillaume for the comparison of line standards.

He has trained a number of pupils in spectroscopy, pure and applied, specialising on molecular spectra of diatomic gases and infra-red spectra. He has also organised a laboratory for the investigation of dielectric properties of liquids and gases.

He is a fellow the Institute of Physics and Physical Society of London; German Society of Engineers and Fellow of the National Institute of Sciences, India. He has been recently appointed by the Government of Bengal to act as the chairman of the Bengal Industrial Survey Committee.

MATA PRASAD

President, Chemistry Section

Professor Mata Prasad, born in February, 1898, took the M.Sc. degree of Allahabad University in 1922. He was



appointed as a research scholar of the U. P. Government in 1922; worked under Dr S. S. Bhatnagar, D.Sc. O.B.E., the present director of Industrial and Scientific Research Board, for D.Sc.; and took the D.Sc. degree of Benares Hindu University in 1925. He was appointed a professor of inorganic and physi-

cal chemistry at the Royal Institute of Science, Bombay, in 1925. He was elected a fellow of the Institute of Chemistry, London, in 1934 and a fellow of the National Institute of Sciences, in 1935. He worked with Professor Sir William H. Bragg, F.R.S. at the Laboratories of the Royal Institution, London.

M. R. SAHNI

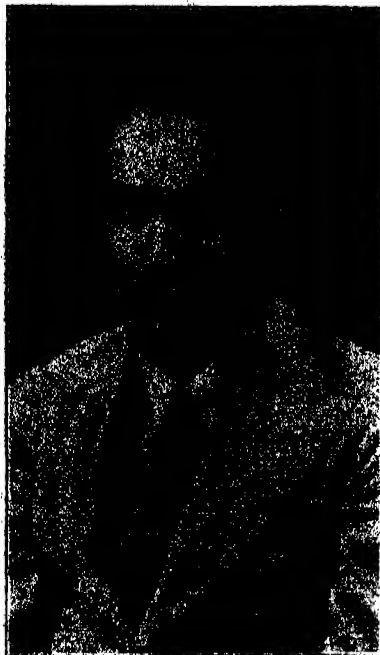
President, Geology Section

Dr M. R. Sahni was educated at Cambridge and proceeded to the natural science tripos in 1922 from

the Emmanuel College. He subsequently specialised in geology and for his researches at the School of Mines, London he was awarded the Ph.D. of London University. He was later given a research scholarship for 3 successive years by the D. S. I. R. of Great Britain and was further awarded the Marshall Grant for research by the Imperial College of Science, London. At the invitation of the natural history

section of the British Museum he undertook further investigations and was awarded the D.Sc. degree by London University. During his research career he was invited to give a demonstration of his research methods and technique at the Royal Society. On his return from England, Dr Sahni joined the staff of the Geological Survey of India and has carried out field work for a number of years in the Shan States

of Burma. He has held the post of palaeontologist in the department. Recently Dr Sahni has been engaged in the investigation of the mineral deposits of Sind.



S. M. TAHIR RIZVI

President, Geography and Geodesy Section

Dr S. M. Tahir Rizvi obtained his Ph.D. from London University and is chairman of the department of geography at Muslim University, Aligarh.

SHRI RANJAN

President, Botany Section

Born at Benares in August, 1899, Dr Shri Ranjan received his early education at Calcutta and graduated in 1921 from Benares Hindu University. The stimulating influences of Prof B. Sahni, F.R.S., and Prof. Inamdar added encouragement to his interest in plant life and other natural objects and he took up botany for his post-graduate studies. Working under the renowned plant physiologist Prof F. F. Blackman, F.R.S., at Cambridge he obtained the

M.Sc. degree of Cambridge University from Trinity College.

Returning from Cambridge he joined the University of Allahabad as reader in botany, where he has initiated plant physiological researches. Later, he proceeded to Europe, took the State doctorate (tres honourable) of France and visited some famous laboratories. He has been elected a fellow of the Indian Academy of Science as well as of the National Academy of Sciences.

His work is mainly concerned with plant respiration, and his researches have proved that light profoundly affects the rate of respiration of a green plant. He has also interested himself in physiological investigations for the improvement of agricultural crops. New mutant types of Pusa wheat have been produced by exposure to X-rays. It has been shown that application of molasses to the soil results not only in an increase of soil nitrogen but also in the nitrogen content of the plant and its carbohydrate and chlorophyll contents; yield is also greatly increased. By administering suitable concentration of ethylene gas in the laboratory he has been able to produce the black-tip disease in healthy fruits just as is common in the plant near brick-kilns.



A. SUBBA RAO

President, Zoology Section

Born in February 1890, Dr Rao graduated from Central College, then an affiliated institution of the University of Madras, where he had Professors C. R. Narayana Rao and M. A. Sampathkumaran as his teachers. After graduation he worked for a year in the entomological laboratory of the agricultural department under the guidance of Dr L. C. Coleman, and in 1914 he joined the staff of the zoology department of the Central College, Bangalore. In 1920 he joined the department of zoology and comparative anatomy of the University College, London, and in 1922 he was awarded the M.Sc. degree for

his thesis on the morphology of the amphibian and reptilian heart. He was elected the same year to the Derby studentship, University College, University of London, which he held for two years. During this period he successfully worked out the development of the sympathetic nervous system and suprarenal bodies in the bird and his researches on the mammalian placenta carried out under the direction of Professors Hill and Watson formed a valuable contribution to our knowledge of the subject. He was awarded the D.Sc. degree in 1925.

With the starting of the Medical College in Mysore, the Government of Mysore offered Dr Rau a Damodar Dass Scholarship to qualify himself in physiology. He worked under the guidance of Professor A. V. Hill and Dr Anrep for two years and obtained the M.Sc., degree in physiology for his thesis on coronary circulation.

On his return to India, Dr Rau was appointed to the chair of physiology in the University Medical College, then in Bangalore. He was actively engaged in teaching physiology to students of medicine and most of his time was occupied in organising and building up the department. He however sustained his living interest in zoology by his researches into the anatomy and embryology of *Loris lydekkerianus* and published a series of papers in the *Journal of the University of Mysore*. In 1933

he was elected to one of the three British Empire Universities Carnegie fellowship and as a fellow of the Foundation he went again to London to acquaint himself with modern development and advances in his subject. Dr

Rau is at present professor of zoology at Central College, Bangalore where

he was transferred in 1937 after Prof. C. R. Narayan Rao's retirement. In 1935 Dr Rau gave Sir S. Subramanaya Iyer Memorial Lecture of the University of Madras.

Dr Rau is secretary of the Indian Academy of Science and is associated with several scientific organisations of the Mysore State.

Y. RAMCHANDRA RAO

President, Entomology Section

Born in September, 1885, Mr. Y. Ramchandra Rao was educated at Madura and Madras, having obtained M.A. degree in zoology in 1907 from Madras Presidency College. After his graduation in 1903 he joined the Madras Agricultural Department in January, 1906 as entomological assistant. After a preliminary training under Prof. Maxwell Lefroy at Pusa, he was engaged in a systematic survey of the crop pests of the Madras Presidency and was in charge of the

insectary at the Agricultural Research Institute at Coimbatore from 1913 to 1916. From November, 1916 to March, 1919 he was on special duty under the imperial entomologist, Pusa, for studying the indigenous insect pests of *Lantana* in India and Burma.

From October, 1919 to December, 1920 Mr Rao was on deputation under the Government of Iraq to organize work in agricultural entomology in that country. He was appointed government entomologist in Madras in 1928. He was specially deputed for the locust research scheme under the Imperial Council of Agricultural Research and was locust research entomologist at Karachi till the termination of the scheme in March, 1939.

He attended the third International Locust Conference, London in September 1934 as a delegate representing India. He was awarded the title of 'Rao Bahadur' in January 1936, following 'Rao Sahib' in 1920.

T. C. DAS

President, Anthropology Section

Born in January, 1898, Mr. T. C. Das received his early education at Tangali and Rajshahi. He took

his M.A. degree in ancient Indian history and culture from Calcutta University and was one of the first batch of students who received academic training in anthropology in India. In July 1921 he joined the then newly created department of anthropology of the University of Calcutta as a research scholar and is now the senior lecturer in social anthropology. He has made a study of some of the aboriginal tribes of India and has conducted field-work among a large number of tribes inhabiting the uplands of Chota Nagpur, the hinterland of Orissa and the Indo-Burmese border. Mr Das has two monographs on Chota Nagpur tribes.

A. C. UKIL

President, Medical and Veterinary Research Section

Dr A. C. Ukil graduated in medicine from Calcutta University in 1914. He was awarded Ghosh travelling fellowship for 1929-30 and was the recipient of Coates medal in 1935. He was for some time a professor of bacteriology at the National Medical Institute, Calcutta. He is at present head of the Tuberculosis Inquiry, Indian Research Fund Association and

head of the department of chest diseases, Medical College Hospitals, Calcutta, in both of which capacities he has been all along a honorary worker. He is a member of the Society of Tropical Pathology, Paris; fellow of the Royal Sanitary Institute, London; fellow of the Royal Society of Tropical Medicine and Hygiene, London; fellow of the State Medical Faculty of Bengal (*honoris causa*); fellow of the National Institute of Sciences of India; and is secretary, Indian Committee, International Association of Microbiologists.

K. RAMIAH

President, Agriculture Section

Mr Ramiah after a brilliant career at the Agricultural College, Coimbatore, joined the Madras Agricultural Department as a research assistant to the economic botanist in 1914. He was closely associated with

F. R. Parnell, the then economic botanist who started work on rice and he has had a large share in the later expansion of this work when he succeeded Parnell. The present premier position of rice research in

Madras is, in no small measure, due to the work of Ramiah himself. During his long association with rice research (1914-1927), except for a break of two years when he was away in Cambridge, England, on deputation, a large number of scientific publications on rice genetics and a popular handbook on rice stand to his credit. The spread of improved strains evolved by him in several parts of Madras has resulted in considerable material benefit to the rice

growers of the province. He was awarded M. B. E. in 1938.

Since April 1937 he is on deputation working under the Indian Central Cotton Committee as its geneticist and botanist at the Institute of Plant Industry, Indore. He represented India recently at the seventh International Genetics Congress held in Edinburgh in August, 1939.

B. B. DIKSHIT

President, Physiology Section

Born at Amraoti, Berar, in 1902, Dr B. B. Dikshit graduated from Grant Medical College,

B o m b a y, in

1924. In 1926

he obtained his D.P.H. from

the Calcutta

School of Tropical Medicine

where he later worked as a

g o v e r n m e n t

scholar on indigenous drugs in

the department of pharmacology.

In 1929 he was appointed professor of

pharmacology, Medical College,

Vizagapatam.

He proceeded to Edinburgh in 1932 and passed the M.R.C.P. examination and later obtained Ph.D. of the University. At Edinburgh he served for some time as assistant to professor of pharmacology. In 1935 he came over to India as a pharmacologist in the Medical Research Department of the Government of India. At present he is the officer-in-charge of the department of pharmacology, Haffkine Institute, Bombay.



I. LATIF

President, Psychology and Educational Section

Dr I. Latif took his M.A. degree in philosophy and while acting as a professor of philosophy and psychology he specialised in experimental psychology. After eight years' teaching he proceeded abroad and studied under Dr E. B. Holt and Dr H. S. Langfeld at the University of Princeton, N. J., in the United States of America where he received his doctorate in psychology. He also worked as a

part-time lecturer in the department of psychology in the University of Princeton for one academic year.

His main research work has been on linguistic development, certain types of clinical studies and various aspects of

educational psychology. At present he is the head of the department of philosophy and psychology of Forman Christian College, Lahore and the director of the Child and Youth Guidance Clinic there.



C. C. INGLIS

President, Engineering Section

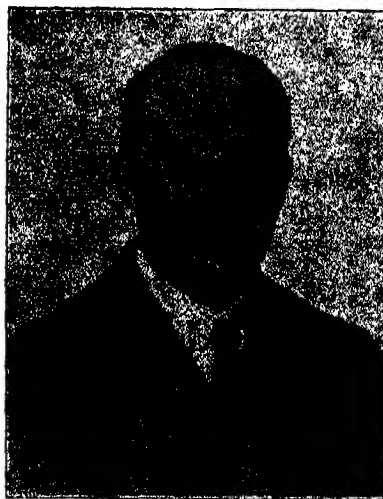
Mr. C. C. Inglis, was educated at Shrewsbury and Trinity College, Dublin. Posted in 1906 to the Jamrao Canal, the most modern Canal in Sind, he worked under the late Sir Frederick Cebble, who later became consulting engineer to the Government of India. In 1911, he was transferred to the New Godavari Canals to introduce Sind methods of irrigation in the Deccan, and after one and a half years

became executive engineer, Poona Irrigation Division, in charge of the Nira and Mutha Canals and Poona Water Supply. Here he undertook the work of co-ordination of agricultural requirements and irrigation limitations. Canals were soil surveyed and sugar cane blocks were divided into $\frac{1}{2}$ acre units on the Nira Left Bank Canal, so that a known discharge could be given to known areas. Subsequently, unitisation was also introduced on Godavari and, eventually, on all canals.

A strong advocate of the necessity of encouraging sugar factories, even when the only factory was in financial straits, he, in the face of strong opposition, was responsible for selecting suitable areas for companies, and by foreseeing the need of factories for seed of the new Java varieties and planting considerable areas of these for seed, aided the companies when they were starting to expand. There are now many sugar companies and the whole supply of the canals is being fully utilised.

At his recommendation a research division was sanctioned at Poona from June 1916 and he was placed in charge. This in later years has served as a nucleus of the present Central Hydrodynamic Research Station, which is stationed at Khadakvasla, 11 miles from Poona. The Station has solved many of the waterway difficulties, particularly with regard to the construction of bridges and anicuts.

From 1927 onwards he worked as superintending engineer successively of Irrigation Development and



Research Circle and of Deccan Irrigation Circle. In 1937 he was appointed to his present office of director of Central Irrigation and Hydrodynamic Research. Though in charge of research continuously from 1916,

he has mainly concentrated on co-ordination and practical application of various lines of research of his own and other departments.

In addition to the Station work, Mr Inglis has been dealing with many problems acting in an advisory capacity and is a member of the Orissa Flood Advisory Committee. He was on deputation in America in 1921 and 1939 and in Germany in 1929. He is author of many papers on land drainage, reclamation, irrigation, river training and allied subjects.

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Jute Research

THE Royal Commission on Agriculture which reported in 1928 were of opinion that the problems of advancing agricultural research in India must, broadly speaking, be dealt with as a whole and not in sections. But with regard to jute they made an exception. The history of indigo was a striking illustration of the dangers that may beset a monopoly crop. They foresaw the possibilities of an artificial product that may be discovered and placed on the market at a price which will enable it to replace jute. The Commission therefore considered it most desirable that a Jute Committee which would watch over all branches of the trade from the field to the factory should be formed. In focussing the problems of jute industry on the public mind and drawing public attention to the organisation necessary for its scientific development this journal can claim some share.* After tiding over the great depression of 1929-30, in May, 1936, the Government of India decided to establish the Indian Central Jute Committee on an all-India basis with headquarters in Calcutta. The Committee has been functioning since February, 1937, when the inaugural meeting was held. The plan of research "envisages continuous research over every stage of production, marketing and manufacture, from the seed available to the cultivator to the preparation of the finished article, and also the provision of an improved service of statistics and information". The technical activities of the Committee

have been divided into four sections: (1) agricultural research, (2) technological research, (3) marketing, and (4) statistics and information. Besides the annual report for 1939-40 the Committee has brought out this year a *Review* of the work done during the last three years and a few months, from December, 1936 to March, 1940.

The Agricultural Research Laboratories of the Committee are situated at the Dacca Central Farm. The site ensures close and continuous co-operation between them and the agricultural department of the Government of Bengal. It is a little over a year that research work on the agricultural side may be said to have commenced in right earnest. Agricultural research on jute was first started by the fibre section of the department of agriculture as early as 1906, and the research section as an essential preliminary to its research work has compiled a review of all the past work on jute. The section has undertaken experimental plot trials with a large collection of varieties and types, which are being continued to arrive at conclusive results. Investigations into the fibre structure have yielded data for estimating the fibre content of a plant from examination of a slice of its stem under the microscope. Cultural trials have also been taken in hand. The three diseases, viz., (a) stem-rot, (b) chlorosis, and (c) black band of the stem are under study. That the infection of the disease known as stem-rot reaches down to the surface of the seed and is also carried deep into it is an important finding made at the Committee's Agricultural Research Laboratories at Dacca.

* See SCIENCE AND CULTURE, Vol. I, pp. 308-312 and 661-664, 1930-31.

A detailed survey of the pests of jute undertaken by this section showed that the jute-apion, the jute-semi-looper, the hairy caterpillar and the indigo caterpillar were the most common pests of jute plant. Resistance of varieties to jute-apion was studied in some detail and certain control measures against the jute semi-looper and the hairy caterpillar were adopted with success. Two unrecorded pests were also observed. Jute semi-looper damages the top leaves, the indigo-caterpillar also strips the plants of its leaves and the hairy caterpillar spreads very quickly on the leaves. But the jute-apion's weevil lays its eggs in the stems and the grub out of the egg feeds on the bark and the internal tissues. The fibre is damaged and gummy substance produces knot in the fibre. On the production side, retting of the jute plant is a very important factor, and the effect of the quality of water on this is under investigation. The relationship between the stage of harvest and the time required for retting and that between retting period and thickness of stem are also under observation.

At the Committee's Technological Research Laboratories at Tollygunge, improvements were made in the technique of spinning yarn from small samples of fibre. As a result of numerous spinning tests, broad correlations between the strength, fineness and flexibility of the jute fibre, on the one hand, and the quality-ratio and the regularity of the yarn on the other are about to be established. Work to correlate the physical properties of the fibre like strength, fineness, flexibility, colour and lustre with the spinning qualities and to indicate relation, if any, with chemical constituents like nitrogen, fat and wax, lignin, total cellulose and with moisture and ash content is proceeding. Long exploratory work on these lines regarding the particular properties to look after has suggested the above programme and the necessary apparatus and instruments have been procured. In co-operation with the Indian Jute Mills Association, work on the moisture content of jute has been carried out and the results so far obtained indicate that it will not be long before agreed figures for the normal regain of jute are arrived at. As experiments at the Laboratories proved that sugar bags made of rosella cloth were more suitable than those of jute from the point of view of moisture absorption, efforts are being made to reduce the hygroscopicity of the latter. Experiments were also undertaken to find out if seaming twines could be made from jute to replace Italian hemp.

The primary duty of the Marketing Section of the Committee was to complete a survey of conditions governing the preparation for sale, marketing and transport of raw fibre at all stages from the hands of the growers to the Calcutta mills, presses and markets. This work was successfully carried out and the first marketing report was published early in September. Some developmental work with regard to grading and co-operative sale was also undertaken during the period under review.

As the unreliability of the official jute forecast had been a subject of comment for many years past, one of the first tasks of the Indian Central Jute Committee was to evolve a technique of forecast based on the method of random-sampling. Accordingly small scale experiments were conducted during 1937, 1938 and 1939 to work out the details of this method in the Statistical Laboratory at Presidency College, and to try them out on the field. As a result of three years' investigations, the technical problems involved in this method appear to have been well-nigh solved. The first try-out of this method on a provincial scale will take place next year.

The collection of reliable information on all matters affecting the jute industry including research and enquiry into the economics of jute has been another important activity of the Committee and the monthly *Bulletin* serves to give due publicity of these.

The *Review* points out that some fundamental work may require the help of university laboratories, which includes the study of methods of distinguishing a jute fibre from a mestha fibre in mixed yarns, examination of the mode of association of cellulose and lignin in jute and similar fibres, botanical and chemical diagnostic characters of *Oltorius* (tossa) and *Capsularis* (white) varieties and X-ray photographic study of jute and similar fibres. Recently distinguished scientists representing the Universities of Dacca and Calcutta have been co-opted as members of the Technological and Agricultural Research Sub-Committees and we hope closer and fruitful collaboration will ensure. It is desirable that a weaving section should be started along with the spinning one as early as possible. The ultimate thing is the fabric and not the yarn, and until a yarn, pure or mixed, be woven into cloth, it is hardly possible to judge its worth from the practical point of view. In our opinion, the Technological Research Laboratories should have no restriction to limit their activities to the investigation of jute alone.

After it has completely organised its research departments, it might serve as a nucleus of a long-fibre research institute. Attempts should be made to produce suitable mixed fabrics, e.g. with wool, flax, cotton etc. Work should be started to woollenise jute by suitable chemical treatment and produce cheap winter clothing for our people. Germany presumably utilised much of her imported jute for this purpose. In a poor country like ours, such winter clothes will have a ready sale.

On the chemical side vigorous attempts should be made to find out new uses of jute. If this be successful, India alone will consume most of her own production and the present crisis will largely disappear. It is worthwhile to see if jute stick can profitably serve as a source of cellulose in paper-making and the like and if the jute fibre would be a suitable raw material for rayon manufacture.

Already while serious attempts are being made in other countries to replace jute by some other fibres, several experiments carried out in recent years have shown that jute in its turn can be used in place of other materials. A few examples may be given. An Austrian firm has discovered a good substitute for metal, called "Jutex", which is composed of jute and artificial resin. It is used for making containers and for the manufacture of cog-wheels of all sizes. Jute has been used by a Dundee inventor as one of the ingredients in making synthetic shafts for golf clubs. Bitumen-proofed jute cloth has been used successfully in Cuba in covering pineapple plantations. Hessians, coated with paints on both sides, are also used. A German firm invented a method of using fire-proof jute fabric for lining roofs, floors and walls of houses. A South African farmer produced better quality wool by clothing half of his sheep in

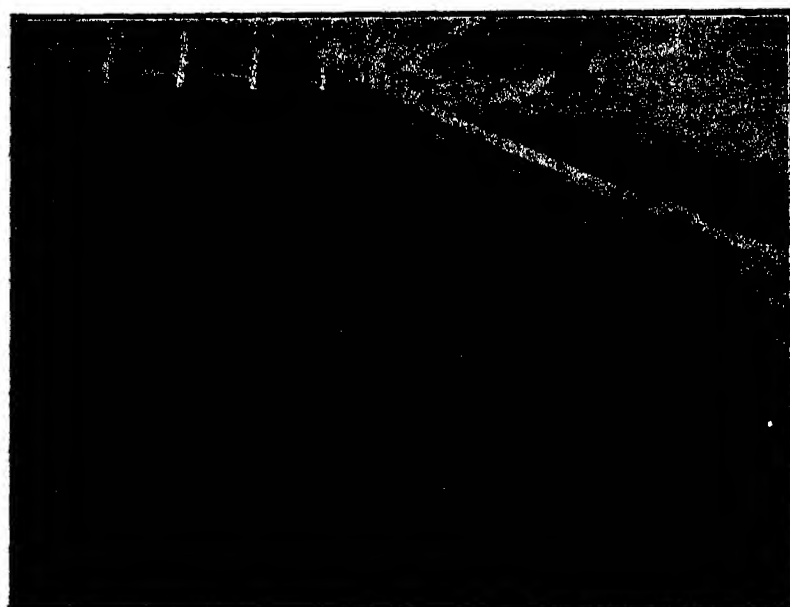
closely woven hessian coats to protect their wool from dirt and severe weather. Jute fibre, after proper activations, has considerable water-softening powers similar to those of Zeolite materials. Activation consists in treatment with dilute acid, washing and treatment with salt solution. Experiments on the use of jute cloth in road-making have been carried out in different parts of the world with partial success. In the construction of concrete roads jute cloth has proved very useful. These roads are however not suitable for heavy traffic.

We understand the Committee is planning to undertake researches on these lines, and a scheme involving an expenditure of Rs. 3,85,000 (non-recurring) and a sum between 10,000 and 40,000 (recurring) was drawn up some time ago. The scheme for extension of the Laboratories at Tollygunge has recently been accepted in principle by the Government of India and detailed estimates are under scrutiny. Research on jute in view of its special position among the agricultural crops is, for the present, entirely financed from the central exchequer. It was however suggested during the establishment of the Committee that finances may be secured from uncertainty, inevitably attached to annual budget grants, by imposing a differential cess on exports of raw jute, sacking and hessian. The proposals were not carried into legislation as the jute trade was likely to oppose the bill at that time due to adverse conditions prevailing then. The original grant to the Committee was Rs. 5 lakhs which has unfortunately been reduced to Rs. 4½ lakhs. The resolution of the Government of India on the establishment of the Committee assured that the financial position would be renewed after five years or earlier, if necessary. Let us hope that a way out of these shrinking finances will be found out.

- (ii) to see the effect of building a short spur at the corner of the Right Afflux Bund to protect the latter from attack due to increased discharge in the Solani Got channel.

A series of experiments were first conducted to reproduce prototype conditions, the criterion being that the model, laid according to 1936 conditions, should reproduce the development of 1937 conditions.

- (c) Short groynes pointing 45° downstream constructed at three points along the eastern face of the Kala Jala island were tested to see the effect on pulling the main stream across to the Kala Jala island. Only the central groyne was effective; but it was not recommended, because the natural tendency of the river under 1938-39 conditions was to swing over from the



← Sarda Barrage & Main Canal.

← Short spur at corner of Right Afflux Bund to protect it from scour.

← Solani Got channel.

FIG. 2

1/150 to 1/50 vertically exaggerated model of the Sarda at Banbassa (U.P.) with the short spur at the corner of the Right Afflux Bund to protect it from scour. Looking downstream.

Experiments were carried out for 3 to 5 season floods, the maximum discharge being equivalent to 522,000 cusecs.

- I (a) Extending the Nepal Spur failed to cause any considerable curvature of flow and had no effect on reopening of the Western channel.

- (b) Two bunds, one to divert water into the Central channel running through the Kala Jala island and the other into the Western channel were tested with a view to increasing the flow through these channels. They however failed to establish sufficient curvature.

Nepal Spur to the eastern face of the Kala Jala island.

- (d) As described in the 1937-38 Annual Report, extending the Burma Spur 20° downstream of the present alignment was effective in diverting the flow from the Eastern channel away from the Left Afflux Bund.

II. Experiments with a short spur at the corner of the Right Afflux Bund showed that the short spur

- (a) was effective in protecting the Right Afflux Bund by diverting the high velocity flow away from it;

- (b) reduced silt entering the Canal, and
- (c) improved flow conditions by diverting the main channel outside the Divide Wall (see Fig. 2).

towards the Right Afflux Bund. This was foreseen and was expected to be prevented by constructing a long spur upstream in the vicinity of the old Boulder Bund on the Solani Got channel, $1\frac{1}{2}$ miles above

FIG. 37. PLAN OF BRAHMAPUTRA RIVER.

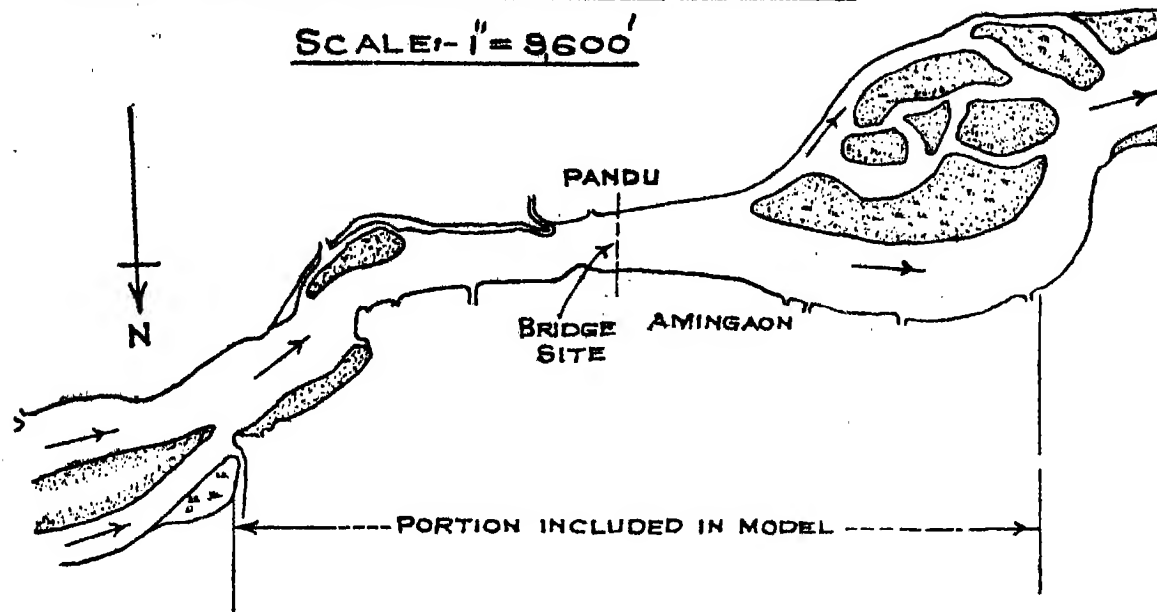
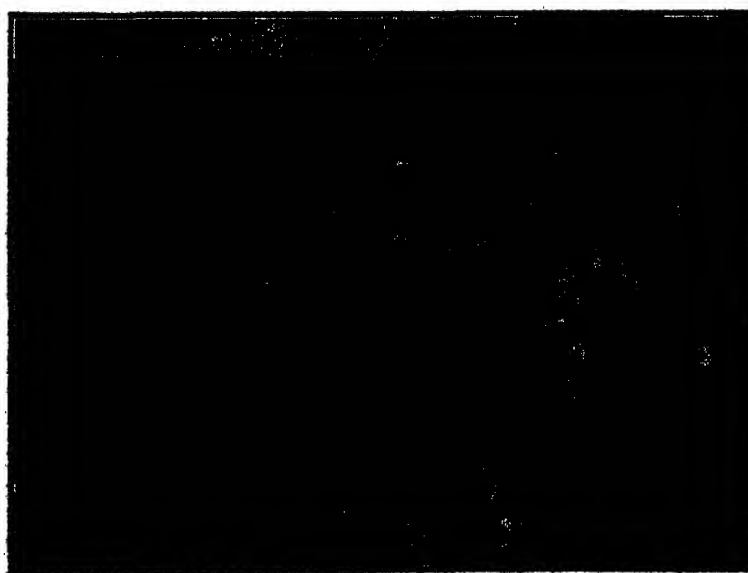


FIG. 3

The only point on which it gave undesirable results was that it had a tendency to pull the upstream flow

the Barrage, for which experiments were in progress in 1939-40.

Model of the Sarda River (U.P.) under construction.



← Silt channel.

FIG. 4

Model of the Brahmaputra at Amingaon where a Railway Bridge is proposed by Eastern Bengal Railway. Looking downstream.

**FLOW CONDITIONS AND SCOUR ROUND PIERS OF THE
PROPOSED RAILWAY BRIDGE AT AMINGAON ACROSS
THE BRAHMAPUTRA ON EASTERN BENGAL RAILWAY**

Figure 3 shows the plan of the Brahmaputra with the proposed bridge site.

The aim of the experiments was

- to reproduce and examine conditions of flow in the prototype,
- to estimate scour caused by a maximum flood,
- to determine the effect on scour of adding piers and guide banks ; and
- to determine the best method of stone protection round the piers.

The results showed that:

- Water followed the expanding banks downstream of the gorge, and the flow at the Bridge site was sweet ;
- Upstream of the gorge, which is 2400 ft. above the proposed Bridge site, scour is deep ; but there is no danger of this scour moving downstream, because it is local, due to exposed rock and concave curvature of the river ;
- When piers were added, the general conditions of flow at the Bridge site were unaffected ;
- The stone pitching of the guide banks of the bridge should conform as nearly as practicable to the existing banks, so as to interfere as little as possible with present flow conditions. So, instead of stone being laid as an apron and allowed to

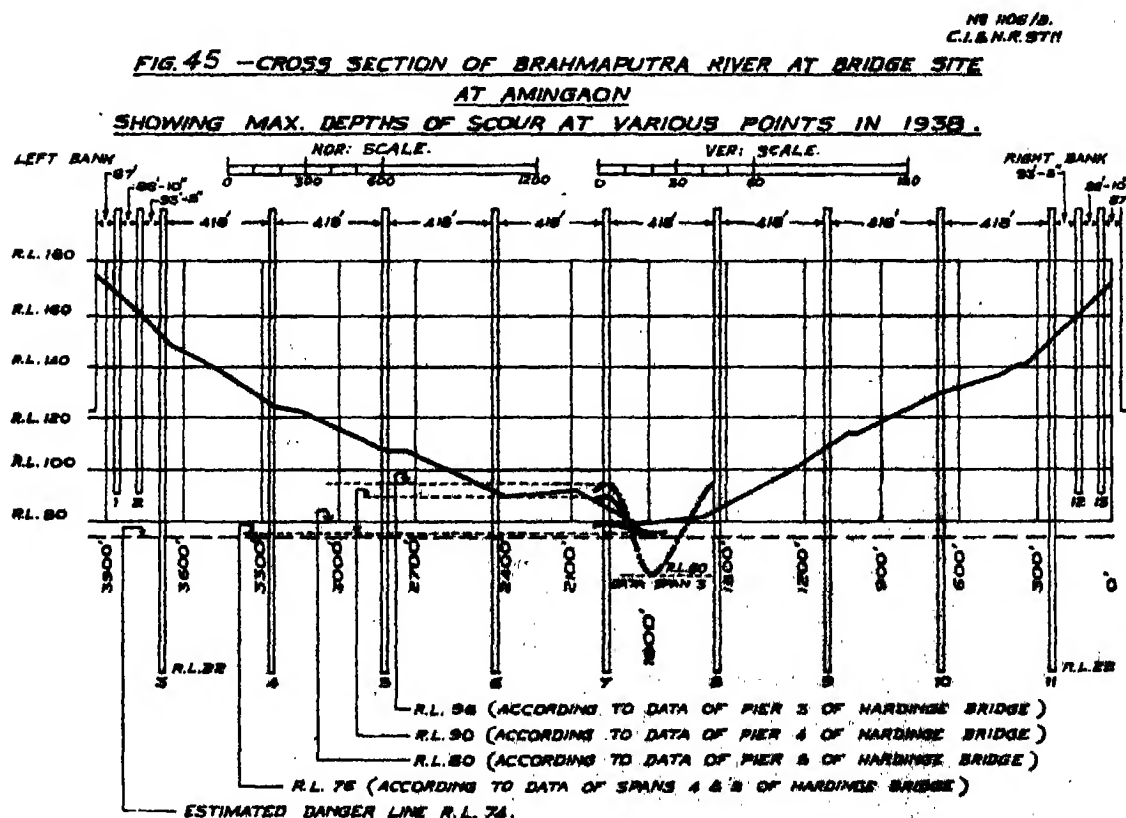


FIG. 5

The scale ratios of the model (Fig. 4) were:

Horizontal	scale	ratio	=	1/300
Vertical	"	"	=	1/40
Discharge	"	"	=	1/94,800

launch, sand should, where practicable, be removed and the stone laid where finally desired.

The flood data of 1937 and 1938 showed that scour commences at the Bridge site when the

discharge exceeds about one million cusecs, and reaches a maximum on a falling flood. During a very rapidly rising flood, the river does not scour

The level at which the pitching would stabilise around piers of the Brahmaputra Bridge was worked out to R.L. 80.0 by method (A) and to R.L. 83.0 by method (B), compared with which the assumed safe level of scour is R.L. 74.0 (the bottom of piers is at R.L. 22.0), see Fig. 5.

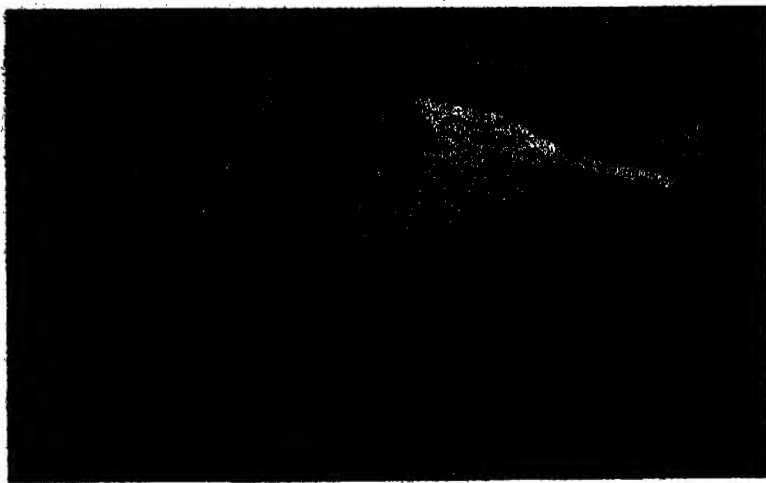


FIG. 6

Training of the Watrak near Kaira (Bombay). Showing vertically exaggerated model with causeway, which caused silting downstream near the old Fort wall, by diverting high velocity flow away from it. Looking downstream.

and may actually silt accompanied by a very rapid increase in velocity; whereas during a steady flood, scour takes place and the velocity and gauge readings drop. For this reason, the discharge gauge graph is not reliable, scatter for different conditions being very wide.

The estimated maximum flood discharge worked out by indirect methods was less than $2\frac{1}{4}$ million cusecs.

As it was not possible to reproduce scour round the piers in a vertically exaggerated model, conclusions were drawn

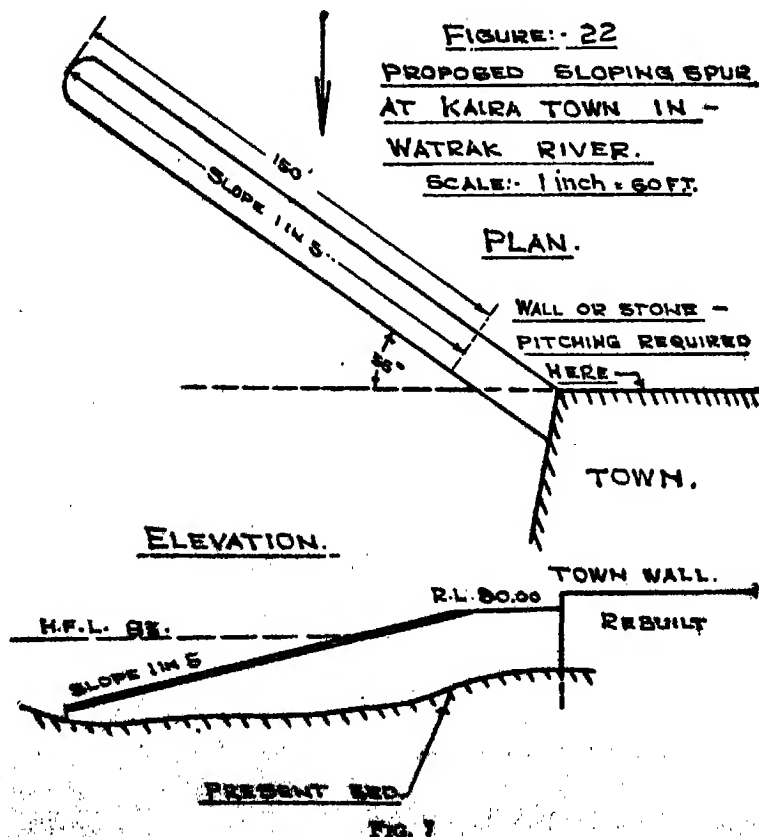
(A) by direct application to the Brahmaputra Bridge, of known scour round the Hardinge Bridge piers; and

(B) by applying to the Brahmaputra piers results of experiments carried out with models of Hardinge Bridge piers under steady, axial flow conditions.

TRAINING THE WATRAK RIVER TO PROTECT KAIRA TOWN, GUJERAT

Erosion had been taking place at a sharp bend of the Watrak river just upstream of Kaira town. The north-west corner of the town wall had collapsed into the river as a result of the attack and there was every indication that the erosion would extend.

The primary object of the experiments was to indicate how the corner of the town could be protected, but it was also desired to deflect attack away from the wall of the town downstream and reduce erosion at the bend upstream. Independently of this problem,



it has been proposed to construct a causeway or bridge across the river at Kaira.

Experiments were carried with a model constructed to a scale of $1/125$ horizontally and $1/45$ vertically, in which the effects on the river course of

- (i) spurs of various designs placed at the corner of the town,
- (ii) a causeway, and
- (iii) a bridge, on various alignments,

were tested. Certain alternatives were also tested in

Recommendations made, based on these experiments, were in the form of alternatives:

- (1) To construct the bridge in the best position for protecting the town and training the river from the N.-W. corner of the town (Fig. 6).
- (2) To construct the bridge below the town protecting the town by a spur 180 ft. long extending into the river, sloping down at 1 in 5, pointing 35° upstream (Fig. 7).

NR 1187.
C. I. & H. R. 8TH

FIG. 29 - PLAN OF NALA BELOW AQUEDUCT 14,

N. R. B. CANAL.

SCALE - 1 INCH = 1320 FT.

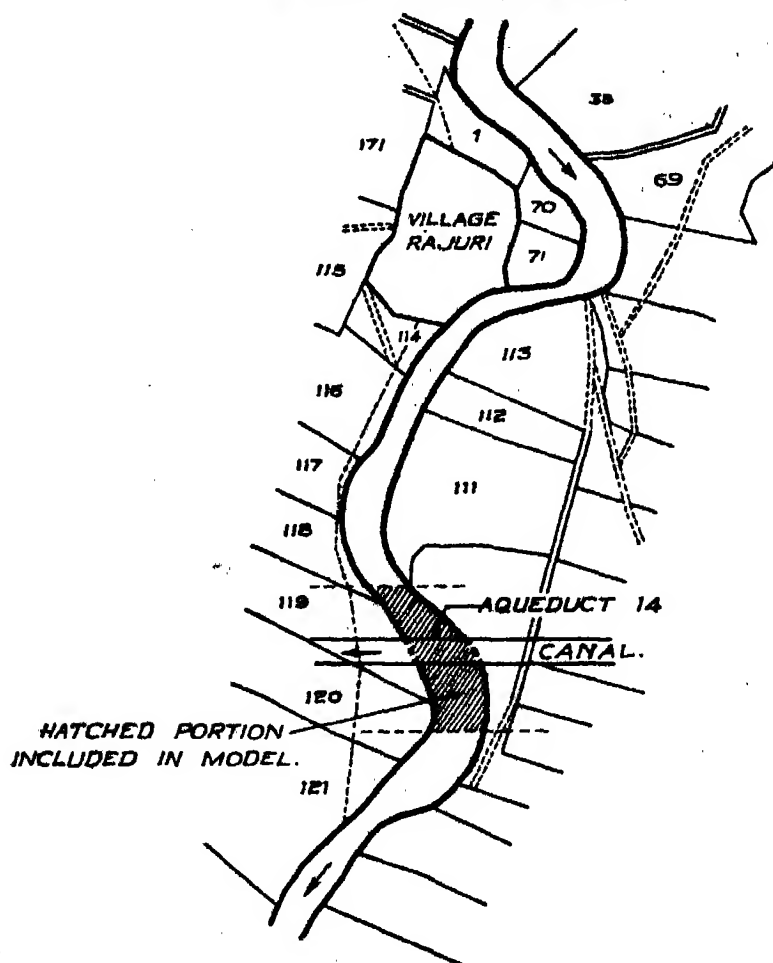


FIG. 8

geometrically similar part models of scales $1/30$ and $1/40$ in which the flow and local scour conditions could be examined in more detail.

Of these (1) was better than (2) but the choice depended on cost and on the desired location of the bridge. The second recommendation was adopted.

**TRAINING THE RAJURI NALA BELOW AQUEDUCT
NO. 14 ON THE NIRA RIGHT BANK CANAL
(BOMBAY PRESIDENCY)**

The Rajuri Nala flows through the Aqueduct 14 from the right flank at an angle of about 45° (Fig. 8). The toe of the right upstream wing wall collapsed during the severe floods of 1937 due to the wing wall being overtopped by $2\frac{1}{2}$ ft. and the backing bursting through.

- (2) Plain weir falls.
- (3) Notch falls.
- (4) Montagu type flumed falls.

It has been found that the standing wave flume meter fall with a baffle, cistern and deflectors gives very satisfactory results for large discharges, say, greater than 4,000 cusecs, and the bigger the fall, the greater is the efficiency. They are especially



FIG. 9

1/5th scale model of 700 cusecs. Standing Wave Flume Meter Fall, showing the effective working of the baffle. Looking upstream.

Experiments were done with a $1/25$ geometrically similar model with a view to reducing afflux by straightening the flow upstream. Sweeter flow and less afflux were obtained with a curved wing wall and a groyne 200 ft. upstream on the right bank ; but a warped wing wall without a groyne was recommended, as it was nearly as effective and did not depend on the maintenance of a separate groyne.

DISSIPATION OF ENERGY BELOW FALLS

Experiments have been in progress^a at the Station with various types of falls, viz.:

- (1) Proportional standing wave flume meter fall.

advantageous when the fall is to be bridged and is to work as a measuring device.

(i) Experiments with a proportional Standing Wave Flume Meter Fall

During the year, experiments were carried out with a standing wave flume meter fall design required for 700 cusecs fall on the Montgomery Pakpattan link (Punjab), where 3 different types of fall were proposed to be constructed with a view to seeing their working in actual practice. These experiments were continued with a $1/5$ th scale model of a 700 cusecs proportional standing wave flume meter fall. To overcome the slight instability of flow obtained with 25% retrogression in downstream water level, the best results were obtained

^a Bombay P.W.D. Tech. Paper No. 44: "Dissipation of energy below falls" by C. C. Inglis, and D. V. Joglekar.

with 1 in 8 side divergences; vanes in continuation of piers; a sloping glacis; a baffle platform; a baffle 1.6 ($d_c - d_2$) high (d_c = critical depth and d_2 = depth at toe of fall); a flat pavement of bowed cross section; bed and side slope deflectors and two rows of control blocks. This design was finally adopted.

(ii) Experiments with a non-proportional Standing Wave Flume Meter Fall

Flumed falls designed to be proportional—no afflux or draw-down throughout the range of discharge—have a lower hump and narrower throat

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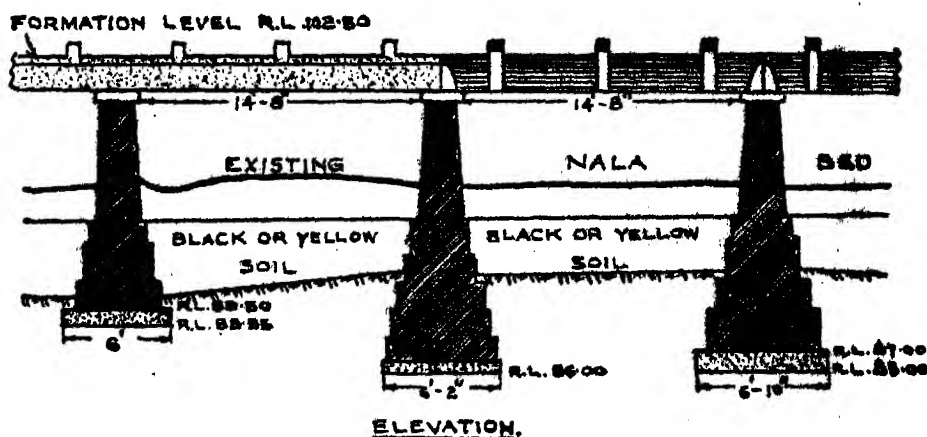
SUBMERSIBLE BRIDGE

OVER

KALAMBA NALA (C.P.)

SCALE 1"=10'

HIGH FLOOD LEVEL R.L. 114.



SUBMERSIBLE. BRIDGE

OVER

KNARMER RIVER

SCALE 1"=10'

1935 FLOOD WHICH CAUSED DAMAGE.

~~RL 87-75~~

PREVIOUS HIGH FLOOD LEVEL RL. = 84.0

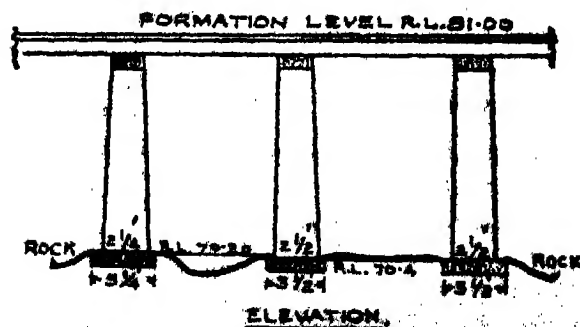


FIG. 10

than would otherwise be necessary. This adds to the length of expansion and thus increases cost. Proportionality is frequently not required; for example, the general practice in Northern India is to run canals only at full supply. An alternative design to that described in (i) above was therefore tested, having a high non-proportional hump (0.4d₁) and wider throat, all tests being carried out with 25% retrogression in downstream water level. There were two rows of control blocks, bed and side slope deflectors as in design (i) and best results were obtained with baffle 1.1(d₁ - d₂) high (Fig. 9).

It may be stated, in general, that when proportionality is not a necessity, a standing wave flume fall with a high hump is likely to be cheaper and give as good or even better results.

EXPERIMENTS WITH MODELS OF SUBMERSIBLE BRIDGES

Several submersible bridges situated in the Central Provinces are damaged during floods, the slabs being carried away bodily and deposited downstream in the bed of the river (Fig. 10).

Models were constructed of two bridges which had been damaged. It was found that, even when

maximum flood discharges were reproduced, the slabs in the model did not move or show any tendency to be lifted with steady flow; and this was borne out by pressure observations.

Experiments using slabs of various weights showed however what had happened in the prototype. Owing to the turbulence of flow the slab was subjected to rapidly fluctuating upward and downward pressures, as a result of which the horizontal force of the current was enabled to push the slab downstreams in short jerks, until suddenly it would overbalance and, pivoting on the downstream end of the supports, be caught by the current and deposited on the bed of the channel. The likelihood of this happening in the prototype would be increased by the collection of the floating trees etc., against the upstream edge.

The cause of the damage to the bridge was therefore concluded to be, not the steady uplift pressure, but the action of turbulent flow, on unanchored slabs. The improvement on rounding the upstream edge was found to be small. It was suggested that any means of preventing the slab from sliding on its supports would reduce the danger of failure.

Electron Microscope

N. N. DAS GUPTA

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IN a previous issue of this journal (Vol. 4, pp. 691-7, 1938-39), was given a preliminary account of the electron microscope. Since the publication of that article a great deal of improvement has been effected in the design of the different parts of the instrument. The result of these changes has been a great increase in the power of resolution and in the total magnification of the electron microscope. Due to this enhanced efficiency it has been possible to gain new insight into the processes which were far beyond the reach of even the most powerful microscopes. Giant molecules can now be seen and photographed and the destructive action of a phage on bacteria can be followed stage by stage. In the present article we shall summarise the development of the electron microscope as well as mention very briefly the new results brought to light by the investigations carried out with its help.

The new high-power electron microscope employs a magnetic lens, instead of an electrostatic one, for accurate comparison between the two has shown that with the same accelerating potential and limiting focal length of the objective, greater resolution is obtained with the magnetic lens. The object and the objective system now form one unit so that the position of the object with respect to the objective remains absolutely fixed and the instrument is insensitive to mechanical shocks. The space between the object and the camera, that between the object and the objective as well as the whole condenser system have been thoroughly screened with permalloy. The objective works with real diaphragms of 5.15μ diameter which may be easily interchanged by a simple manipulation. An analogous interchange of diaphragm arrangements in the condenser system allows one to pass over from working with a light field to that with a dark one. The sharpness and the position of the intermediate and the final pictures can be controlled by means of a monocrystal

light screen which is inserted in the outer zones of the radiation. The picture is observed with an ordinary light microscope. With the dark field pictures the intensity of light on the zinc sulphide screen provided is sufficient to permit visual focusing. Only in the case of the dark field pictures of highest resolution which demand real objective diaphragms of diameter less than 7μ , the intensity drops so much that exposure times of the order of 1 min. are necessary. The pictures reproduced on the next pages were taken with Schumann plates which have high resolving powers. Owing to the small aperture, the electron microscope possesses a depth of focus which is 100 to 1000 times greater than that of an optical microscope. Arrangements have therefore been made for taking stereo-pictures of the same section of the object at two inclinations of about 4° - 15° on the average.

It is important to mention here that the final magnification of any picture consists of two parts, the first by the electron microscope and then by photographic methods. The most favourable distribution of the two magnifications depends on the resolving capacity of the sensitive layer for highly accelerated electrons. With plates of high resolving power (Schumann) smaller microscopical magnifications are favoured, for, then a greater field of view is available and owing to the decrease in exposure time the destructive effect of the radiation on the objects is less. However, only the total magnification is interesting which has been given under every picture. The capacity for resolution can be judged from the object distance of 1μ or 0.1μ marked on every picture.

Figure 1 shows a photograph of haemocyanin molecules obtained on a collodium foil (conc. 10^{-7} gm/cm³) magnified 75,000 times. This is the first photograph of molecules. It confirms what was

previously inferred from sedimentation experiments that these copper-containing molecules constituting the blue blood-pigments of the snails

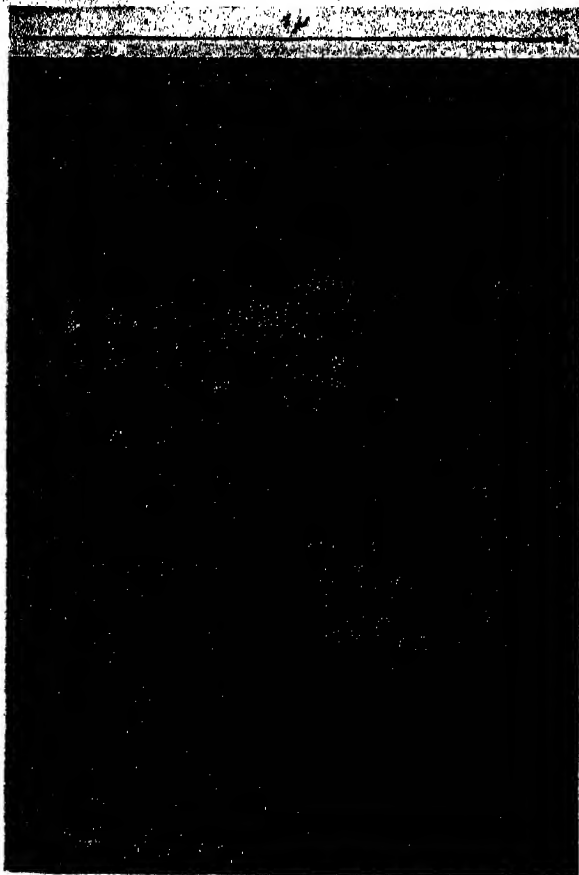


Fig. 1

First photograph of Molecules. Haemocyanin on collodium foil. Magnified 75,000 times.

have globular shapes. The diameter of these molecules appear to be 2×10^{-6} mm. The very small photographic contrast is due to the fact that here single molecules lie on a collodium foil which is about equal in thickness to the molecule diameter. The photographs obtained with higher concentrations give only a cloudy appearance.

Figure 2 is the case of a proteus bacteria caught just at the moment of division. Strange structures are visible inside the two halves of division.

An interesting study, made possible by the new electron microscope, has been the phages and their destructive effect on bacteria. We have, as it were, just begun to peep into a new world of neglected dimensions whose gates were so long closed to us.

With the powerful optical microscopes one could see the various bacteria which are usually so small that a number of them may remain comfortably within a single red cell of human blood. The normal red corpuscle is about 25μ in diameter and the bacteria may be 1μ or less in thickness and 3 or 4 times as long. Hence in an optical microscope of two thousand times magnification, a bacteria of say 6μ thick 2μ long will be visible as a spot of 1.2 mm. by 4 mm. The phages which are still smaller bodies and are beyond the range of optical microscopes, could only be inferred in medical science on account of their destructive effect on various bacteria. With the electron microscope we can not only see the phages but can actually go a step forward and follow the various stages of the action of a phage on bacteria.

The following four figures (3-6) illustrate the action of the bacteriophage lyse. After the addition of lysates to coil bouillon culture the phages appear within a very short time adsorbed on the bacteria surface which is sharply defined (Fig. 3). Soon afterwards the contours of the bacteria surface appears to become more and more indistinct and the protoplasmic contents come out (Fig. 4). Finally, with the exception of the resisting nucleus the whole bacteria is invaded by the phages (Fig. 5). An interesting phenomenon in the successive stages of the action of a phage on bacteria is the appearance of crystalloids (Fig 6).

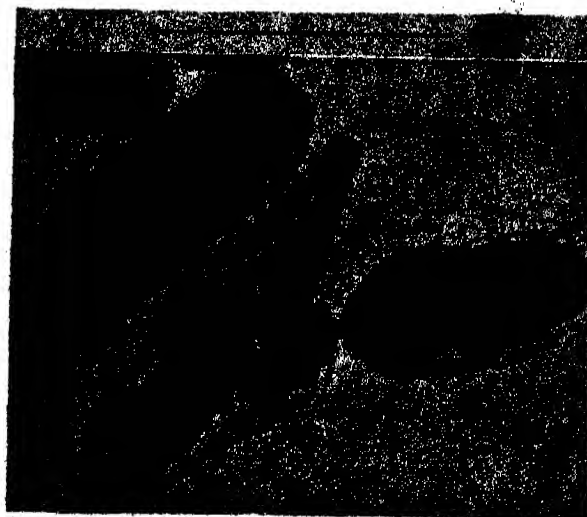


Fig. 2

Proteus bacteria just before division

The phage itself is a small round body which appears to be homogeneous and considerably thick.

With highly intense electron radiation they appear to be destroyed and only ring-formed hollow globular bodies are left behind. This phenomenon is very similar to that observed with cubic

identified with the centres of origin of the phage proteins.

The electron microscope which is a new gift of physics to medicine is still in its infancy. But it bids fair to show that it will soon prove itself to be



Fig. 3
Coliphage on bacteria surface.
Magnification 15,000 times



Fig. 5
Coliphage on the resisting bacteria centre.
Magnification 14,000 times



Fig. 4
Coliphage on bacteria surface.
Second stage. Magnification 14,000 times



Fig. 6
Crystalline formations inside bacteria.
Magnification 14,000 times

crystals. The similarity of reactions of the two bodies with regard to electron radiation seems to justify the assumption that possibly both are similarly built up and that the crystalloids are to be identified with the centres of origin of the phage proteins. The electron microscope which is a new gift of physics to medicine is still in its infancy. But it bids fair to show that it will soon prove itself to be

one of the most valuable weapons of medical research in its ceaseless fight against disease.*

* The photographs reproduced above are from the work of Ruska and Ardenne, *Naturwissenschaften* 3 and 8, 1940.

How Far Census in Bengal is Accurate ?

JATINDRA MOHAN DATTA

WHAT IS CENSUS

WE all know what census is. "A census in modern times is an official enumeration of the inhabitants of a State or a country, with details of sex and age, family occupation, possession, etc.", says the *Cyclopaedia of Law*. In Bouvier's *Law Dictionary* it has been defined as "an official reckoning or enumeration of the inhabitants and wealth of a country." The plain dictionary meaning of census is "an official registration of the number of the people, the value of their estate and other general statistics of the country." (Webster). In the Indian Census Act, 1939, census has not been defined ; but from the tenor of the several sections it may be taken to mean primarily an official enumeration through direct visitation of all the people with various data concerning the persons enumerated, such as religion, caste, marital condition, etc.

A census is a sort of photographic record of population group at a given moment, and resembles a periodic taking account of stock in business. The scientific importance of a census lies in large part in the fact that it furnishes the needed basis for a study of changes in the number of people through births and deaths, immigration and emigration, and of changes in their status through marriage and divorce, etc. Speaking of the utility of taking census, the *Encyclopaedia Britannica* (14th edition) says, "Census statistics are the common tools and materials of the business of Government in ways too numerous to detail ; but they are equally indispensable to the direction of State policy."

CENSUS AS A GUIDE TO STATE POLICY

We want to prevent child marriages by altering the law. Let us examine its frequency. In England the legal age for marriage of a male was, until very recently, fourteen. There is no record of a man marrying at 14 since the marriage of the Earl of Ormonde in the reign of Charles II. Law or no law,

people in England do not marry early, or marry their children early. But what is the position in India? In 1921 we find more than 300,000 of infants below five married. If we consider those who are below 10 to be children, we find 4 per cent of them married. The necessity of the Child Marriage Restraint Act (the Sarda Act) becomes apparent at once.

We want to introduce compulsory free primary education. If we consult the census statistics, we can get an idea of the number of children we have to provide for.

We want to see whether female infanticide is practised among certain tribes in the Punjab and Rajputana ; the sex-proportion among them compared with that among the general population there at once gives us the clue.

We want to see whether the age at marriage is increasing at such a rate that we shall have to face the problem of 'old maids' ; the census statistics provide an answer.

Such is the importance of census.

INACCURACY IN OUR CENSUS

The British Imperialists at Whitehall want to devise a new instrument of 'Divide et Impera' ; and they have not failed to manipulate the census for their own purpose. They manufacture castes and classes among the Hindus ; wrongly include certain castes and classes among the Muhammadans ; convert the untouchable Muhammadan Halalkhors of 1901 into Depressed Hindus of 1931 ; and put them as one of the Scheduled Castes under the new Government of India Act, 1935. Their main purpose is to see that there can never be unity amongst the different sections of the population, and thus sabotage the growth of the Nationalist spirit. The result is that our Censuses are not accurate pictures.

CENSUS IN ANCIENT TIMES

The term census is borrowed from a Roman institution of a quite different character. The Roman

census was a register of adult male citizens and their property, and it was undertaken for purposes of taxation, the distribution of military obligations and the determination of political status. But the idea of the census seems to be far older. In the Bible, we find mention of the enumeration of the fighting strength of the children of Israel during the Exodus, and of the non-military Levites. In the *Arthashastra* of Kautilya (c. 300 B.C.) we find among the duties of the Gopa—the village accountant :

"Having numbered the houses as tax-paying or non-paying, he shall not only register the total number of inhabitants of all the four castes in each village but also keep an account of the exact number of cultivators, cow-herds, merchants, artisans, labourers, slaves, and biped and quadruped animals, fixing at the same time the amount of gold, free labour, toll and fines that can be collected from it (each house)." (see Shama Sastry's *Arthashastra*, Ch. XXXV).

Scientific interest in the application of the numerical method to the study of population-groups seems to have been undeveloped in the ancient and medieval world. The *Ain-i-Akbari*, the great administrative and statistical survey of India under Emperor Akbar completed by his friend and minister Abul Fazl in 1596-97 A.D., contains a wealth of information regarding the Moghul Empire "faithfully and minutely recorded in their smallest detail with such an array of facts illustrative of its extent, resources, condition, population, industry and wealth as the abundant material from official sources could furnish". These are the words of the translator H. S. Jarret and he is forced to remark that "regarded as a statistician no details from the revenues of a province to the cost of a pine-apple, from the organisation of an army and the grades and duties of nobility to the shape of a candlestick and the price of curry-comb, are beyond his microscopic and patient investigation"; but the *Ain-i-Akbari* says nothing of census or house to house enumeration.

It was in 1661 that Riccioli, an Italian, made first serious attempt to estimate the population of the earth; and in 1662 John Graunt in England, of a large city like that of London. About a century elapsed before these beginnings developed into a national census along modern lines. During the interval various attempts to enumerate the population of cities, provinces or countries were made, but no successful attempts were made to count the whole population of a large country.

HISTORY OF MODERN CENSUS

The honour of introducing the modern census has been claimed by Sweden, Canada and the United States. The periodic enumeration established in the colony of New France in 1665 and continued in Quebec until 1754 has been called by Sir Aethelstane Baines "the earliest of modern censuses".

Sweden's claim to priority is based on a census taken in 1749, which according to Guinchard merits recognition as the first original census. This was the first of a series which the Swedish Government has continued without interruption up to the present day.

Faced by a serious and threatening political problem the Fathers of the American Constitution of 1787 inserted therein a provision that an "enumeration shall be made within three years after the first meeting of the Congress of the United States and within every subsequent term of ten years." The provision for a decennial census grew out of a protracted controversy between the large and small States. Under the Constitution then in force, each State had one vote; and the Congress had only one Chamber. In the Constitutional Convention, the small States insisted on retaining their equality; the populous and wealthy States demanded weightage in the Councils of the Nation proportional to their population and wealth. The compromise adopted provided for a Legislature of two Chambers, in one of which *viz.*, the Senate, the claim of the small States was allowed; while in the other, the House of Representatives, the claim of the large States was granted. When the agreement was reached, it was a short step to recognise that a periodic re-adjustment of the number of representatives in the lower House to changes in the population or in the wealth of the States was desirable. It was decided to base representation on population, to count slaves as three-fifths of the same number of free persons (for the purpose of increasing the representation of a State, and at the same time denying them franchise!), and to enumerate the population every ten years.

The first Federal Census of the United States was taken in 1790 and it has been repeated since then every ten years. Statisticians of repute all over the world are agreed that the census taken in 1790 is the first scientific census in the modern sense of the term. There can be no doubt that the periodic censuses of the United States have been pre-eminently

responsible for introducing the practice in other countries. The British House of Commons, in 1753 feared that a numbering of the people would be followed by "some great public misfortune or epidemical distemper"; the first census of England was taken as late as 1801. Ireland was censused in 1821; other countries followed the practice sooner or later. In India, provincial or local censuses were taken in different areas between 1853 and 1868. The City of Calcutta was censused in 1866; full five years before the general all-India census. As a part of the great Imperial scheme conceived during Gladstone's administration, the first all-India census was taken in the winter of 1871-72.

The practical value of periodical enumeration has now been recognised throughout the civilised world, although for financial or political reasons or administrative difficulties, the census has not yet become a universal institution. It was estimated in 1901 that 55 per cent of the population of the world are censused. The estimate is given below in a tabular form:—

Continent	POPULATION IN THOUSANDS		Percentage enumerated
	Enumerated	Estimated	
Europe ...	387,308	6,314	98.4
Asia ...	323,569	550,713	37.0
Africa ...	19,741	144,578	12.3
America ...	135,118	10,543	42.8
Oceania ...	4,711	881	84.5
Total ...	870,447	713,029	55.0

Since then census-taking has been carried to more remote countries until by now nearly three-fourths of the earth's estimated total population of 2136 millions has been enumerated. The proportion is steadily rising; and if we except China, the only unaffected and populated regions are Bhutan, and the Muhammadan countries of Afghanistan, Iran, Iraq and Arabia; and the interior of Africa. China has some sort of census, which though not strictly census in the modern sense of the term, is much better than mere estimates. Incidentally we may mention that it has been estimated that the Earth can maintain a population of 6,000 millions, a total which will be reached about 2100 A.D., at the present rate of increase.

CENSUS IN INDIA

Although there was a general all-India census in 1871-72, certain outlying and backward areas were not censused. At each successive census more and more inaccessible regions were reached until in 1921 the whole of India was within the census net.

The nominal increase in the population censused in India since 1872, together with the variation is shown in the table below:

Census of	Population in 000's	Variation in 000's	Variation per cent since last census
1872 ...	206,162	...	...
1881 ...	253,896	47,734	+ 23.2
1891 ...	287,315	33,896	+ 13.2
1901 ...	294,361	7,046	+ 2.5
1911 ...	315,156	20,795	+ 7.1
1921 ...	318,942	3,786	+ 1.2
1931 ...	352,838	33,419	+ 10.6

But the real gain is considerably less than this figure owing to two factors, (a) the additions of area and population included at each census and (b) the progressive increase in the accuracy of the enumeration from census to census. It is clear that their influence must steadily decline as organized administration extends and the system and practice of enumeration improve. According to the *Census Report for India* in 1921, and *India in 1930-31*, the general result, after allowing for the factors of extension and accuracy, is as given in the table below.

(Figures in millions)

Period	Increase due to Inclusion of new areas	Improvement of method	Real increase in population	Rate % of real increase
1872-1881	33.0	12.0	3.0	1.5
1881-1891	5.7	3.5	24.3	9.6
1891-1901	2.7	0.2	4.1	1.4
1901-1911	1.8	...	18.7	6.4
1911-1921	0.1	...	3.7	1.2
1921-1931	0.1	...	34.0	10.6
Total	43.3	15.7	87.8	30.7

It will be noticed that neither the Census Commissioner for India in 1921 nor the author of *India in 1930-31* claims any improvement of method since 1901. The census of 1871-72 was not a one-day or one-night census like the later ones. In all later censuses from 1881 to 1931, the enumeration was of all persons physically present on the day or the night of the census. This year (1941) the census is going to be a *de jure* one, i.e., of all persons who are normally present or resident at a given place, spread over a period of two weeks. The increase in accuracy of enumeration due to the change from the non-synchronous method of 1871-72 to one-day synchronous census of 1881 was about 6 per cent. It is feared that the change from *de facto* method of enumeration to *de jure* one will lead to inaccuracy of enumeration. As we have estimated elsewhere (see the *Modern Review* for January, 1941, p. 94) the inaccuracy will be of the order of 3 to 4 per cent.

It is claimed for the *de jure* census that it is a better record of sociological facts. It all depends upon the angle of vision. The summer population of Darjeeling—of persons normally present and resident there in summer—is very different from its winter population. And it is well known that Darjeeling owes its prosperity to its summer population. Both the *de facto* and the *de jure* methods of taking census have certain advantages as well as certain disadvantages.

WHY THE INDIAN CENSUS IS LIKELY TO BE INACCURATE

In the special circumstances of India, particularly of Bengal about which the author can speak from personal knowledge, especially in view of the unpaid, temporary, non-official agency employed for enumeration and collecting data, the *de jure* census is less likely to record true facts, and as such will be more inaccurate. The 'Supervisors' are equally unpaid, temporarily impressed non-officials. The 'Charge Superintendents' in the interior of rural Bengal are the local Union Board presidents this time. Some of them are scarcely literate; and most of them lack the zeal and public spirit necessary for correct enumeration and proper collection of data regarding the persons enumerated.* Imagine such men

* We know of a Union Board, within 20 miles of Calcutta and a few miles from the Sub-Divisional headquarters, where even the collection of Union rates is systematically neglected and the pay of the Chaudhars and the Daffadars are habitually in arrears, but the same group of persons would be elected members and President term after term because of their local influence, and according to our information, a large percentage of Union Boards are of this type.

conducting the census enumeration—the importance of which they do not realise and a thing which do not affect their...

As for official organisation and supervision by the Government, we cannot do better than quote an extract from an official letter: "In the (district town) census office, as elsewhere, there is no whole time census staff. All the clerks, as well as the district census officer himself, have the regular work of their departments to attend to, in addition to the duties which census imposes on them. In all offices census clerks are working overtime."

This is the organisation which is expected to supervise the work of the rural charge superintendents i.e., the Union Board presidents. There are more than 5,000 Union Boards in Bengal; and the work of 5,000 Union Board presidents as charge superintendents has got to be supervised by the 27 district census officers, who are at best part-time officers. Besides these Union Board areas, there are 118 municipalities with an industrial and floating population; and sparsely inhabited tracts of the Sundarbans and the Chittagong Hill Tracts, and areas where there are no Union Boards.

CLAIMS OF THE CENSUS SUPERINTENDENT OF 1931 EXAMINED

The Census Superintendent of Bengal claimed an accuracy of enumeration of one per mille for the whole population in 1931 (see § 4 of the *Bengal Census Report, 1931, Part I*). Is the claim justified? Is it possible under Indian conditions? The *Encyclopaedia of Social Sciences* says:—

"The accuracy of a Census is ordinarily judged by the accuracy with which the population has been counted, and that total under American conditions, is, according to the expert opinion of Francis Walker and Carrol Wright, probably within one per cent of the truth."

In America the Negroes are enumerated less accurately than the Whites, and the probable error of the count may be as high as two per cent according to the same authority.

If the accuracy of enumeration in civilised America with an almost cent per cent literacy, and a permanent Census Bureau of Statistics is within one per cent of the truth; can the claim for an accuracy of one per mille for Bengal be maintained when the literacy in the province is as low as 31.0

per cent; and where the Census staff is appointed once in ten years? To this must be added the effect of political movements like Non-co-operation and Civil Disobedience Movements started by Gandhi; and communal prejudices and propaganda.

TESTS OF ACCURACY OF A CENSUS

"The testing of the accuracy of a Census is difficult because there is no standard more trustworthy by which its results can be measured. But a census is sometimes discredited by the inconsistencies between its different results or by divergences between its figures and those of later enumerations." thus observes the *Encyclopaedia of Social Sciences*. The accuracy of a census is ordinarily judged by the accuracy with which the population has been counted. But a complete census is composed of answers to many enquiries, each with its own degree of error.

(i) Let us apply this test to Indian censuses. Let us concede that the Census of 1921 was correct to within one per mille as claimed by the Government officials. According to the 1921 Census, the numbers of males in selected age-intervals were as follows:—

1921—CENSUS				
Age-interval	...	0—5	15—20	20—55
No. of males	...	29,76,538	22,06,286	19,51,338

Ten years later, they would shift to the categories 10-15, 25-30, 30-35. Let us now scan the figures given in these age-categories in 1931.

1931—CENSUS				
Age-interval	...	10—15	25—30	30—35
No. of males	...	31,77,539	23,97,513	22,12,514
Increase over 1921 figures	...	7%	9%	14%

How is this increase possible, for in the extreme case of no deaths amongst persons belonging to these categories—in itself an improbable assumption—the numbers can at best remain stationary. But the Census report itself says that the specific death rates were 65·2, 13·7, and 14·4 per mille per annum respectively in this interval. Immigration alone can account for the figures but according to the *Census Report of 1931* itself:—

"During the last two decades there has been a progressive decrease (italics ours) in the total

number of immigrants recorded at the Census of Bengal and a progressive increase of persons born in Bengal and recorded in other parts of India" (see p. 91).

It is therefore as clear as daylight that the number of persons in the different age categories in the 1931, has been *falsely* enumerated. Let us try to estimate the proportion.

A foot-rule with no inch markings is a crude instrument to measure the height of a man; but, still it can be used usefully to find out whether A is taller than B. Vital statistics are useful guides to measure the growth of population. Deaths began to be registered in our country since 1869; and births since 1892. We know how inaccurate the registration of such vital occurrences were and still are. But their accuracy has increased very greatly since Dr Bentley's administration of Public Health Department; and is progressively increasing with the progress of literacy and the development of the local self-governing institutions. They therefore afford a rough measure to test the accuracy of the census statistics. They are the foot-rule with which to compare the inter-censal growth of population.

With reference to the growth of population between 1891 and 1901 Sir Edward Gait in the *Bengal Census Report of 1901* says:—"Generally, therefore, it appears that the difference between the total number of births and deaths shown in the vital statistics returns affords a very close approximation to the actual growth of the population." For Bengal, Bihar and Orissa registered births and deaths accounted for 94·1 per cent of the increase recorded during the census operations.

Vital statistics accounted for more than 62 per cent. of the increase between 1901 and 1911; 59 per cent. of the increase in the next decade; and only 46 per cent. in the last census decade of 1921-1931. In India outside Bengal the vital statistics accounted for 80 per cent. of the increase recorded in the 1931 Census. Here in Bengal the discrepancy is *twice* greater. It is an admitted fact that the accuracy of registration of births and deaths in Bengal is increasing. And their progressive failure to account for the census increase is a sad commentary on the accuracy of the census enumeration. Vital occurrences are collected by a permanent agency; tested by a different touring inspecting staff and the average error of omissions found is of the order of

4 or 5 per cent in the case of both births and deaths, and consequently the error in the increase of population is of the order of 1 per cent; there is a sanction of fine and prosecution for non-registration. Prosecutions for non-registration of births and deaths, though comparatively few, are regularly instituted year after year. As against that we have a huge temporary unpaid staff of non-officials, who are likely to be out of pocket if they are to discharge their duties efficiently, with practically no very close supervision, and with practically no sanction behind it. One cannot institute a prosecution for false enumeration without the sanction of the Provincial Government, which in practice means considerable delay and expenditure of money. And when the sanction arrives, the documentary evidence—the enumeration slips—are cut up for statistical purpose and are therefore not available.

If we assume that the order of accuracy of the vital statistics registered between 1921 and 1931 to be the same as those registered between 1911 and 1921, then of the census increase recorded between 1921 and 1931 (7·3 per cent of the total population), $59-46=13$ per cent is due to the exaggeration in numbers. Working it out as the percentage of the total population it comes to about 95 per cent. Or in other words, the inaccuracy of census enumeration is of the order of 1 per cent.

(ii) Social customs and social habits die hard, especially in the interior of rural Bengal. If there is any change, it is slow and likely to be in the same direction. Family instinct is very strong among the people of Bengal; they live in families. This is especially true of rural areas. In our censuses, houses as well as persons are enumerated. Houses being more tangible, permanent and fixed, the chance of a house escaping enumeration is very much less than that of a man. In our opinion if the chance of a house escaping enumeration is 1, that of a person escaping is 100. From the number of houses, and the average of persons living per house, we can get the number of persons.

If we confine ourselves to rural areas where the population is mainly agricultural and fixed, and free from the disturbing influence of casual and temporary migrants as in towns, and where people live in families, as opposed to artificial messing together in towns or urban areas, we can get a much better and truer estimate of the population from the number of houses.

From the number of occupied houses in villages and number of people residing there, we get the average number of persons per house. The figures for the several divisions of Bengal are:—

Division	Average number of persons per house		
	1901	1921	1931
Burdwan ...	4·56	4·36	4·53
Presidency ...	5·12	5·08	5·11
Rajshahi ...	5·39	5·34	5·31
Dacca ...	5·47	5·46	5·49
Chittagong ...	5·48	5·42	5·40

The average number of persons per house was decreasing between 1901 and 1921 in every division; and it has also decreased in Rajshahi and Chittagong in 1931. But in Burdwan, Presidency and Dacca Divisions the process has been not only arrested but reversed. This is hardly to be expected in rural Bengal.

If we attribute this sudden reversal to be due to the exaggeration in the number of persons, we get an estimate of the number so exaggerated thus:—

Division	No. of houses in 1931	Difference in average No. of persons between	1921 & 1931 Number of persons exaggerated
(1)	(2)	(3)	(4) = (2) × (3)*
Burdwan ...	17,30,362	4·53 - 4·36 = 0·17	294,100
Presidency ...	15,89,886	5·11 - 5·08 = 0·03	47,700
Dacca ...	24,44,843	5·49 - 5·46 = 0·03	73,350
Total			415,150

And this for a rural population of 44,381,158 in 1921 works out to 93 per cent or in other words the exaggeration is of the order of 1 per cent.

(iii) In 1931 each enumerator was to begin the preliminary enumeration with the filling up of schedules carrying as many as 18 columns on the 1st of January and to finish the same by the 1st of February. Even if he has enumerated every person, by the time he submits the preliminary enumeration list for test by the supervisor the list will be out of date by half a month. The number of births in 1931 was 13,88,219; in 15 days there may be as many as 58,000. The number of deaths

in January, 1931 was 105,002; in 15 days 53,000 deaths too place.

On an average each supervisor has to deal with 10 or 12 enumerators, and check entries relating to as many as 400 to 600 houses (see Census Code, 1931, Pp. 16 and 53). He "must examine every entry in every book in order to make sure that the rules have been properly observed." He must be particularly careful to see that columns 4, 8 and 9 to 12 (i.e., entries relating to religion and sex; caste, tribe or race; whether earner or dependent; the principal and subsidiary occupation and the industry in which employed) of the schedule are correctly filled. He is also to see that all persons in every house in his block has been enumerated. He has got so many duties to perform with regard to the entries that he finds very little time for house to house visitation. He must do all these between the 1st and the 24th of February; and return the schedules to the different enumeration for final census on the night of the 26th February. Even if we assume that every supervisor has done this very carefully, in the normal course of events, he will be out of date by 12 days.

On the night of the final enumeration, every enumerator between 7-0 P.M. and mid-night is to correct the preliminary record by striking out entries relating to all persons who have died or gone away and inserting the necessary particulars for newly-born children or new-comers. New entries will be made only at the end of the book.

Theoretically all this is possible; but we doubt very much whether in practice this can be done with data out of date by at least a month, if not a month and a half. The number of vital occurrences in a month total 220,000; and if these are not properly recorded, for a population of 510 lacs, the enumeration is inaccurate by 0.4 per cent. No doubt births and deaths eliminate each other to some extent; but to this we must add the new-comers, or casual and temporary visitors.

When we remember that there were nearly 300,000 enumerators in 1931; and when we remember the fact that even in Calcutta final enumeration was not possible in certain areas, if we allow 1 mistake of enumeration to each enumerator, the inaccuracy of enumeration comes up to 0.6 per cent.

(iv) There is an excess of married males over married females. For 132,28,000 married males we have 126,00,000 married females. Thus there is an excess of over 6,28,000 husbands mostly confined to the Hindus. This excess may be due to *two* causes: (i) inaccuracy in the census enumeration, and (ii) immigration of married males leaving their wives at home. In 1921 the number of married males was 109,37,000 and that of married females was 105,62,000. The excess of married husbands then was 3,75,000. This time the excess has increased by $6,28,000 - 3,75,000 = 2,53,000$.

If it be due to immigration, we would expect an increase in the number of immigrants into Bengal. But the respective numbers of immigrants, male and female, in the year 1921 and 1931 are:—

Year	Total	Males	Females
1921 ...	18,17,775	12,68,828	5,48,947
1931 ...	17,26,370	12,18,038	5,08,332
Decrease ...	91,405	50,790	40,615

We find a decrease in the number of immigrants. The decrease is as much as 5 per cent.

If the excess is due to the inaccuracy of enumeration, it means that for a population of 510 lakhs, the census has failed to account for 2.53 lakhs wives. The error of enumeration comes up to 0.5 per cent.

So in our opinion the claim for an accuracy of one per mille for the 1931 Census of Bengal is not justified.

Plant Viruses

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THE study of virus diseases of plants has of late become one of the active branches of plant pathology. Despite the great interest these diseases have excited, there exists hardly any acid test to show conclusively that any given disease is a virus disease. But certain features stand out clearly. As a rule, the symptoms are uniformly spread over the entire plant and take the form of mottling, streaks, and lesions on the leaves, or on the stems; distortion of the whole plant and alterations in the colours of the flower. These symptoms, like streaks, mottling, and distortion are conspicuous on the young leaves and growing points of the shoot as the viruses have a destructive effect upon the chlorophyll apparatus. The diseases are infectious and of the nature of obligate parasitism. The plants are not outright killed by the virus agents, unless infection occurs in the young or seedling stage, but they appear to pave the way to attack by other disease agents as due to poor nourishment the plants become more susceptible.

The first record of virus disease was published by Charles l' Ecluse in 1576 on a variegation in the colour of tulips, which is now called "breaking" and is recognised to be due to an aphid-transmitted virus. Near about 1770 the agricultural community was greatly perplexed about a disorder, or rather group of disorders in the potato crop known collectively as the "curl-disease". For many years the disease was regarded as the result of prolonged vegetative reproduction that had induced an incurable "senile decay". Later on the works of Quanjer (1916), Oortwijn Botjes (1920) and various others gave a death-blow to this theory of "in-breeding", or "senile decay" and now the degeneration has been found to be due to contamination with viruses.

In 1886 Mayer described a disease of the tobacco plant as Mosaikkrankheit—a term now widely used for describing the mottling type of virus

diseases (mosaic). He was able to demonstrate both the infectivity and the absence of any fungi or bacteria in the infective juice. But a scientific demonstration of the existence of a filterable virus was however made in 1892. Iwanowski proved that the sap from a diseased plant was infectious to healthy plants after passage through bacteria-proof filter. The discovery passed unnoticed until Beijerinck, seven years later, repeated the work and propounded his theory of a "Contagium vivum fluidum."

The relationship of plant viruses with insects forms now a fundamental part of the study of these interesting disease agents and the first definite proof in this connection was given by Takami, a Japanese worker in the year, 1901.

THE NATURE OF VIRUSES

Our information about the heterogeneous collection of these disease-producing agents is still incomplete in some respects and it is rather difficult to give a positive definition of a virus. The definition of three main properties, *viz.*, (i) size below the resolving power of the ordinary microscope; (ii) ability to pass through porcelain filters, and (iii) inability to multiply in the absence of living cells, has been criticised by various workers on this field. Gardner however supplies a working definition of the virus as "agents below or on the borderline of microscopical visibility which cause disturbance of the function of living cells and are regenerated in the process."

It will not be out of place to mention here the general trend of scientific opinion on the nature of these disease-producing agents. The first question of surpassing interest is whether these agents are living or non-living and in this connection Aristotle has rightly said, "Nature makes so gradual transition from the inanimate to the animate kingdom that the boundary line which separates them are indistinct."

and doubtful." The theory of living agent supposes the existence of an organism either of the nature of minute bacterium or possibly belonging to a pre-cellular form of life, whereas the theory of non-living agent supposes the existence of an unorganised toxin which possesses the power of inducing the infected cells to reproduce the agent for their own destruction. Much data and facts have been produced by the two schools of thoughts to support their respective views. In this confused state of our knowledge of the viruses, Rivers' conclusion may be quoted here, "To obtain a better understanding of the viruses it is better to imagine some to be minute organisms, while others may represent forms of life unfamiliar to us, while still others may be inanimate transmissible incitants of disease."

PHYSICAL PROPERTIES OF VIRUSES

The most likely avenue of approach to a realization of the true nature of these infective agents is the study of their physical properties, but the differing behaviour of these agents with different physical and chemical agents renders the subject difficult.

Heat: All viruses whether affecting plants or animals are destroyed at relatively low temperature, but the thermal death-point vary over a wide range, i.e., between 42° — 90°C . with different plant viruses. The viruses do not appear to differ materially from ordinary bacteria in the reactions to sterilization by heat.

Desiccation: The virus of tobacco mosaic remains viable for many years in dried plant tissues, while the virus of tomato spotted wilt, cucumber mosaic, and the X and Y potato viruses are inactivated by desiccation. This is also true of certain animal viruses, e.g., the virus of dog distemper will withstand drying for a time, but on the other hand, the slightest desiccation is fatal to the virus of yellow fever.

Light: Dickson has carried out a number of experiments on the effect of red, green and blue lights of sunlight and darkness upon the extracted sap of diseased tobacco plant and is of opinion that there was an attenuation of the virus in the vials kept under blue, red and green lights in descending order, but found little difference between the red and blue. Darkness and green light were approximately similar in their effect.

The effect of ultra-violet light upon plant viruses was recently carried out by Arthur, and Arthur and Newell and these workers consider that a virus, whatever its nature, can be inactivated by extremely short exposure to ultra-violet radiation, provided it is sufficiently free from impurities. A protective action due to adsorption has been observed if the extracted sap is contaminated with other materials.

Chemicals: The resistance of viruses as a group to the action of glycerol constitutes a point of difference from the behaviour of majority of bacteria which are more intolerant of glycerine. Smith has found that the potato virus X remains viable in 50 per cent. glycerine for 22 days. Klebahn states that the virus of tobacco mosaic will resist glycerine for several days.

Allard has tested the reactions of a number of chemical agents and finds that ether, chloroform, carbon tetrachloride, toluene and acetone have hardly any effect on the infective principle. Fukushima finds in the case of tobacco mosaic virus, that oil of mustard in 2 per cent and digitalin in 5 per cent inactivated the virus in 5 days. Nicotine and atropine in 1-2 per cent concentrations were toxic to the virus.

The effect of alcohol upon a number of viruses has been investigated. Viruses of the tobacco mosaic type will withstand alcohol for some hours up to concentrations of 90 per cent. Potato mosaic viruses are less resistant and are destroyed by 75—80 per cent alcohol, while the virus of bean mosaic is relatively intolerant being unable to withstand 25 per cent alcohol for 30 minutes. Tobacco necrosis has recently been described to be the most resistant virus to the action of alcohol. It remains viable in 99 per cent alcohol for 48 hours or even longer.

Though plant viruses are more or less resistant to certain percentages of alcohol, few plant viruses are able to withstand formaldehyde.

The experiments with trypsin and pepsin on plant viruses is an interesting and important study as it is likely to indicate whether or not these agents are protein in nature. Lojkin and Vinson and Caldwell show that pepsin more likely produces a permanent inactivation of the virus, while trypsin exercises a virus-inhibitory effect and which is only temporary. Until recently, pepsin has been considered to have no proteolytic action upon the virus

of tobacco mosaic and related strains, but this view has recently been challenged. Both taka-diastrase and malt-diastrase freshly prepared from barley had an effect similar to that of trypsin.

Recently however the behaviour of viruses *in vitro* has been studied in greater detail, and some viruses have been found to be amenable to the physical and chemical techniques used for investigation of molecular substances, and as these methods are increasingly applied, the properties of the virus particles are found to resemble those of protein molecules much more closely than those of organisms.

Serological Studies: Animal viruses are endowed with the power of inducing in their hosts a variety of antibodies, but this phenomenon is less well known in the case of plant viruses. A number of serological investigations have been carried out and the rabbit was the animal employed for the production of anti-serum. It has been shown that antibodies produced in rabbits in response to injection with plant virus suspensions have the power of neutralizing or inactivating the suspensions of these viruses. It should be noted here that the injection of plant virus juices showed no pathological symptoms in the rabbit, nor any such virus agent is yet known which is pathogenic to both plant and animal. The neutralizing power of the antibodies produced in this way is rigidly specific, *e.g.*, tobacco mosaic virus is inactivated only by anti-tobacco mosaic serum; cucumber mosaic virus only by anti-cucumber mosaic serum; and tobacco ring-spot virus only by anti-tobacco ring-spot serum.

SIZE OF VIRUS PARTICLES

There are two main methods by which the size of virus particles have been calculated; (i) Barnard's ultra-violet light photography and (ii) Elford's ultra-filtration by means of ether-alcohol collodion membranes. The table on the next column shows under one heading particle sizes of viruses (animal and plant), bacteria and protein molecules, for easy comparison. Rivers however comments on these data and says, "Many of the workers seemed in no way concerned about the possibility that they might have been estimating not the magnitude of viruses, but the size of particles of degraded cells to which the viruses were attached. Unfortunately, none of the figures can be accepted without reservations. At present the exact size of no virus is known."

In this connection the recent discovery of Stanley and others is worth mentioning here. In 1936 Stanley prepared a product of crystalline characters from the juice of mosaic-infected tobacco plants. He claims that the crystals represent the virus agent and are protein autocatalytic enzymes. These crystalline virus agents, on introducing into a suitable host, bring about the transformation of normal cell constituents to a like body. F. C. Bawden has improved on Stanley's technique and has been able to obtain readily such crystals from two variant types of tobacco mosaic. These crystals are absent in the normal tobacco juice. The crystals

NAME	SIZE
<i>Bacillus prodigiosus</i>	750 m μ (diameter)
Psittacosis	275 m μ "
Vaccinia	150 m μ "
Rabies	125 m μ "
Rous sarcoma	100 m μ "
Fowl plague	75 m μ "
Potato virus X	75 m μ "
Bacteriophages	25-60 m μ "
Haemocyanin	24 m μ "
Yellow fever	22 m μ "
Foot and mouth disease	10 m μ "
Oxyhaemoglobin	5.6 m μ "
Tobacco mosaic (Vinson)	5.5 m μ "

(1 m μ = 1 millionth of a millimeter).

from the three sources are identical in appearance and physical properties, and on inoculation to healthy plants bring about the original specific symptoms. The crystals consist of protein, but whether these crystals are in fact the virus agent cannot possibly be affirmed, but that they contain the virus in a highly concentrated form is certain. It may be that the specific virus particles are adsorbed to this crystalline form of protein. Stanley and Wyckoff have isolated a similar crystalline body from plants infected with Wingard's tobacco ring-spot and also non-crystalline heavy proteins from plants infected with virus of the potato and cucumber mosaic.

IMMUNITY

It is probably true that there is no acquired immunity to viruses in plants, but certain species appear to have a natural immunity to a specific virus which affects other closely allied members of the same group, *e.g.*, Potato mosaic virus Y seems unable to infect *Datura stramonium* although it is very susceptible to the other potato mosaic virus X.

Price however describes one exceptional case of apparent acquired immunity to a ring-spot virus on *Nicotiana*. He has found that various species of *Nicotiana* on inoculation with the ring-spot virus develop typical symptoms; later on, these plants recover and finally appear normal. Further inoculation of such recovered plants with the ring-spot virus fails to induce fresh symptoms of the virus. The fact that such recovered plants invariably contain the virus in full virulence and that plants produced from cuttings of recovered plants still contain the virus would seem to suggest that multiplication of the virus takes place within the recovered plants.

Thung and Salaman claim that once a cell is infected with a given virus, no other virus can obtain an attachment, *i.e.*, the presence of one of the two viruses protects against infection by other. Here the protection afforded is rigidly specific and cellular in nature and not humoral as found in the case of animals. Smith suggests that certain viruses make use of particular plant proteins and that the virus which enters the plant first multiplies and prohibits the entrance of another virus which needs similar plant products.

MODES OF TRANSMISSION

The virus diseases can be transmitted from diseased to healthy plants in a variety of ways. The two more important artificial methods of transmission are (i) grafting, and (ii) sap-inoculation, while the natural means of spread are by (i) seed, (ii) transmission through soil, (iii) transmission through vegetative reproduction of infected plants, and (iv) transmission by insects. As space would not permit to describe all these means of transmission, it is desirable to deal briefly the transmission by insects only.

The majority types of insects implicated in virus transmission are those which feed by sucking. Foremost amongst them are the aphides which have been identified to spread about 25 different virus diseases. *Myzus persicae* is alone responsible for spreading 14 such diseases. Next come the hoppers which feed in a similar manner and are responsible for conveying some of the very widespread diseases. Both these families of insects obtain their food, the

sap, by means of a long delicate sucking beak, the proboscis, an ideal injection apparatus. The apparatus is inserted between the palisade cells of the leaf down into the phloem terminals, an area most suitable both for virus multiplication and its rapid distribution about the plant. The proboscis contains two parallel channels, down one of which flows the saliva which mixes with the sap in the plant, while up the other flows a mixture of sap and saliva drawn upwards by a muscular pharyngeal pump situated in the head. Feeding on a diseased plant results in the insect's saliva being contaminated with the virus and the insect on passing to the next plant transfers the disease. It appears that the proteolytic enzymes of insects are more or less like pancreatic trypsin and not of the pepsin type and as trypsin apparently does not digest viruses, there is every likelihood of the virus remaining in an active state in the vector.

As regards the increase or multiplication of the virus agents within the body of the vector, a survey of the different vectors show that both types exist. The leaf-hopper vector (*Cicadula sexnotata*); of aster yellow; the vector (*Eutettix tenellus*) of sugar-beet curly-top and other vectors are capable of retaining the power of infection for a considerable length of time. Considering these examples of prolonged retention of virus, it is difficult to deny the multiplication within the insect. There is however a delay from several hours to several days, in the development of the infective power. This delay has been accounted for in two ways. Firstly, it may be that the virus takes some time to pass through the gut wall into blood and back to the salivary glands before it could be ejected again. This process might account for delays of hours and not for days. The second view supposes these delays to be due to multiplication of the virus agents inside the insect, either in the salivary glands, or elsewhere before an infective 'dose' can be produced and this delay is called the "incubation period". There is a good deal of evidence in favour of this view which at the same time also raises the possibility of an obligate relationship between an insect and a plant virus. This relationship depends upon a variety of factors, *viz.*, method of feeding, pH of salivary secretion, enzymes present in the saliva, permeability of the walls of the alimentary canal and other possible anatomical characteristics.

ECONOMIC IMPORTANCE

The importance and value of the virus diseases affecting animals and men might outweigh those affecting the plant world, but a moment's thought would convince us that if these disorders in plants are not checked, they would endanger many of our staple food crops and through want or malnutrition would invite troubles of no less magnitude. An endeavour has been made here to present some figures showing the actual reduction in yields of more important crops brought about by this kind of infection.

Potato: Brown and Blackman have carried out field experiments and showed that the percentage drop in cropping power varies from 7 to 20, the average being 11·8 per cent, and the corresponding reduction in yield is about 1·2 tons per acre.

Whitehead computes the losses in yield of the potato crop due to leaf-roll to be between 45·6—55·8 per cent. In Germany the loss in potato crop due to two important diseases of mosaic and leaf-roll is round about 20-30 per cent. In England potato virus diseases known as Y and transmitted by aphides are supposed to be the most serious from the point of view of crop production.

Sugar-cane: Faris showed that the reduction in the weight due to the use of mosaic seed is 62·9 per cent. In two series of tests the average annual losses from mosaic over a 5-year and a 3-year period respectively were 11 and 8 tons of cane per acre.

Tobacco: The reductions due to mosaic disease have been variously assessed at 30-50 per cent in yield and 50-60 per cent in value. The reduction in quality is more marked than that in yield.

Cotton: A serious disease known as "Leaf-curl" reduced the yield in a severe attack by 312 lb. of unginned or 99 lb. ginned cotton per acre.

Various other plants: Small cucumbers for pickling has been seriously threatened by the prevalence of cucumber mosaic. The curly-top disease of beet affects the reduction to $\frac{1}{4}$ of that of normal crop. In India the virus disease of Sandal known as "Spike" reduces the value of the yield by 50 per cent.

The above are more important examples. There can be no doubt that the last few years have seen

a slow but steady realization of the importance of study of this group of disease-producing agents. There already exists in foreign countries university departments for the investigation of this type of disease and the time may not be far distant when similar departments will have to be created in the universities of this country also.

CONTROL

The question may now be asked about the protection against these pests from whose attacks there is hardly any recovery for plants. Attempts have been made along several lines and a brief outline of them is given here.

The ruthless eradication of diseased plants, called 'rouging' has been practised with some success in some of the virus diseases. The method must be employed before the disease has spread too widely in the crop. Susceptible weeds or other plants which act as reservoirs should also be removed from the vicinity.

It is also desirable not to grow in close proximity, two such crops which are susceptible to the same virus. Protective field measures against the insect vectors should be adopted since virus diseases depend mostly upon insects for transmission. Protection can partly be achieved by direct attack on insects with the aid of chemicals, by the use of parasitic insects which prey on these insect vectors and also by cultural methods, *i.e.*, by protecting the crop in the seed-beds with screens.

The production of virus-resistant varieties of plants is by far the most promising method. Several good varieties of mosaic-resistant sugar-cane, known as Uba, and POJ strains have been produced. Similarly two strains of cotton resistant to leaf-curl, and designated as XI530 and XI730 have been evolved. Success has also been obtained with long Chinese variety of cucumber against mosaic.

It has been previously stated that inoculation of a plant with a weak strain of a virus will protect that plant from invasion by a more virulent strain of the same virus. A practical use of this phenomenon (vaccination) is being attempted and there is reason to hope that it may succeed. Much work on potato and tobacco on this particular line has been taken up in various countries.

Kunkel claims that if young peach trees suffering with yellows and rosette, are subjected to high temperatures varying from 34°C. to 36°C. for two weeks or longer, they may be cured of virus diseases.

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Notes and News

Largest Solar Observatory in the World

SOME recent additions including a 70-ft. tower telescope made to McMath-Hulbert Observatory of the University of Michigan located at Lake Angelus, Pontiac, Michigan, make it the most well-equipped observatory for studies of the heat, magnetic and other energy conditions of the solar surface. The observatory was started in 1929 as an amateur undertaking by R. R. McMath, H. S. Hulbert and late F. C. McMath and possessed only a 10½ in. reflecting telescope. In 1931 it was made over to the University of Michigan and soon after with the help of a spectrohelio-kinematograph attached to the 10½ in. reflector the first successful motion picture of a solar prominence was obtained. It also became evident that many short-lived solar phenomena, the existence of which had not been hitherto suspected could be photographed. The addition of a 50-ft. tower telescope, in 1936, has made it possible to take 400,000 individual photographs during the past four years, yielding results of great interest and value. Films of motions of solar prominences have been obtained and much has been learnt about the character of the motions and changings on the turbulent surface of the sun. Many questions still remain unanswered and attempts will now be made to gather information regarding the temperatures of the streams of flaming materials, speeds of which have been found to be ten to fifty or more miles per second. More accurate knowledge of the electrical conditions accompanying these solar storms and their connection with such familiar phenomena as the aurora, magnetic storms and interference with radio reception will be sought out. The installation of the 70-ft. tower telescope will thus help to carry out investigations much more in the field of physics than in the field of astronomy. The searching for the real reasons behind solar phenomena employing a powerful instrument and the most advanced techniques of modern physics and astronomy will surely lead to discoveries of great scientific interest and value which may even lend themselves to practical terrestrial applications.

Influence of Sound on Chemical Reactions

IN a recent communication to the American Chemical Society, Dr Walter C. Schumb of Massachusetts Institute of Technology has reported how sound can speed up the rate at which certain chemical reactions take place. It has been generally assumed by scientists that intense sound accelerates certain chemical reactions though it has never been experimentally proved whether the increase in activity takes place because of the noise itself or as a result of heat energy transmitted by the mechanical vibrations. Dr Schumb and his collaborators have shown by means of direct experiment that a vibrating nickel tube partly immersed in a solution is able to accelerate chemical action even when the heat effects resulting from mechanical vibrations are carefully balanced out. The reality of the effect of sound on chemical reactions has thus been established. Within a short time many successful attempts of applying this form of energy and finding new uses of the vibrating unit have been reported by other workers, among which may be mentioned the partial sterilization of milk, the preparation of various kinds of emulsions including photographic emulsions and the bringing about of certain oxidation processes.

High Speed X-ray Photography

AT a meeting of the American Physical Society held on June 21, 1940, some shadow photographs showing the motion of a bullet passing through a block of wood were shown and discussed. For such photography to be successful the exposure has got to be short enough and the photographs were taken by using a very brief electrical surge of high voltage and amperage got by charging a condenser in several seconds and then discharging it through the X-ray tube. During the space of time necessary to take the photograph, the X-ray tube will carry a current of nearly 2,000 amperes at 100,000 volts. In photographing rapidly moving objects, a fine tungsten wire connected in the timing circuit is broken by

the moving object in order that the energy stored in the condensers is released just at the correct instant. This method of high speed X-ray photography will find ample applications in the study of internal strains in rapidly moving machine parts and in the bones of the body in vigorous action. This new type of X-ray tube and technique have been developed in the Westinghouse lamp division by Dr C. M. Slack and his associates.

Stature of Man

TEMPERATURE and not diet has a definite effect on the stature of man, is the opinion expressed by Dr Clarence A. Mills, professor of medicine at the University of Cincinnati Medical College. As a result of studies on 65,000 students in North Carolina, Kansas, Kentucky and Wisconsin showing a tendency towards decrease in stature as compared with past generations and correlating these studies with similar tests on animals, Dr Mills reports that a rise in temperature is associated with a decrease in height. Their studies definitely indicate a reversal of the tendency of former generations to grow taller and reach early maturity. That this cannot be attributed to influence of diet is quite clear, from the fact that the present generation of college students is quite as well fed as their immediate taller forebears. Dr J. W. Colvin of Cincinnati has also carried out animal tests to show that diet is not the controlling factor. Two groups of animals fed on the same diet and otherwise placed under similar physical conditions, were kept at temperatures of 65 degrees and 90 degrees. Those raised in the warmer environment were found to be definitely shorter in stature. Further evidence was presented by Dr Mills showing a relation between a recurring temperature cycle every 1,000 years and the stature of man during the different periods. According to Dr Mills there was high temperature maximum during the Dark Ages and during the same period man's stature fell down by four inches from the days of Greece and Rome. These are verified from the suits of armour in the Tower of London, which would not fit an average lad of thirteen today. About a century ago, Dr Mills observes, a new 1,000 year cycle was entered and the temperature is again on the rise and if his theory is correct we are again beginning to lose in stature as once happened during the Dark Ages.

Large Calcite Deposits in Mexico

A VEIN of vitreous material accidentally discovered by a Mexican prospector and thought to be of no value has turned out to be one of the biggest and

most valuable deposits ever discovered. Around the borders of the crystalline deposit calcite crystals up to 1½ ft. across were found to grow out into the clay bed. No such find has been discovered since the opening of the Iceland spar mine at Helgustadin. Messrs Bausch & Lomb, the well-known dealer of optical grade calcite has contracted to take the entire output of optically suitable crystals from the mine. Within three months more than 500 pounds of fine spar crystal have been taken out. The most important use of calcite is in the construction of Nicol prisms which are used in the construction of many scientific instruments designed both for laboratory purposes and also as an aid to industry. The new source of the mineral, practically the first to be discovered in America, adds additional protection to the optical industry.

Improving Lubricating Oils

THAT the properties of lubricating oil, so far as its wear-prevention qualities are concerned, may be greatly enhanced by the addition of two chemical reagents has been observed by research workers working in the laboratories of the Shell Development Company, California. The names of the reagents have been kept secret but their functions have been explained. The first reagent consists of organic molecules having the form of long threads, which in virtue of their peculiar structure, are able to adhere by chemical forces to the surface of the metal. They consequently greatly increase the tightness with which a film of oil is held between the moving metal surfaces.

Unless the metal surfaces themselves are highly polished and maintain their high polish, lubrication cannot produce fully satisfactory effect. Even the best polish by mechanical means leaves microscopic irregularities on the surface. The second reagent has the property of combining, under the influence of heat generated due to rubbing, with the surface layer of the metal to form low melting point alloys. The chemical polishing agent is so chosen that the whole surface of the metal does not melt or grow hot, but only the minute projecting irregularities melt and flow to a high degree. Laboratory tests have shown that the wear properties of highly refined white oil can be improved ten times by the addition of the chemical polishing agent alone. When the adhesive agent is also used it is increased to nearly 17 times.

Extraction of Metals from Low-grade Ores

METALS which at first appeared to be of little practical importance are often found to have important uses with later technical developments. Such

has been the story of tungsten, molybdenum, manganese, chromium, aluminium, etc. Moreover, times of international stress necessitate the utilisation of substitute products for conventional materials and also the exploitation of low-grade resources which at ordinary times are ignored. H. C. Weber of the department of chemical engineering, Massachusetts Institute of Technology, has after several years of research devised a process for the extraction of boron, beryllium, zirconium, titanium and tungsten from very poor ores. Some important uses of the above metals are already known; military exigencies, availability and technical advances will surely disclose other uses on a wider scale. Beryllium is at present used in alloy with copper for springs to carry electric current. Zirconium has been recently used as a plating on the anode of certain radio-tubes. Boron which is extremely hard and resistant to corrosion will probably find some use as a plating on metals to provide a hard non-corrosive surface. Titanium tetrachloride is being largely used in military smoke screens by airplanes. Boron trichloride may find a similar use. Only low-grade ores containing these metals are found in U. S. A. The process devised by Weber is especially applicable to these types of ores. The process consists of a simplified and improved technique of volatilizing the metal as a chloride from the ore by mixing the same with carbon and passing chlorine or hydrochloric acid gas over it. The metal is then recovered by reducing the chloride and it is practicable to recover the chlorine. The operations may be carried on at relatively low temperatures thus obviating the expenses of altering and maintaining very high temperatures which would be necessary in the earlier chlorination processes.

Aluminizing Mirrors for Astronomers.

LARGE reflectors used in astronomical telescopes were so long formed by depositing thin films of silver on accurately ground glass surfaces, but recently it has been observed that films of aluminium provide in certain respects an improvement over silver films. The reflective power of silver in the visible range is as high as 90 per cent but in a few months time it drops down to less than 60 per cent due to tarnishing. Aluminium on the other hand practically retains its initial reflectivity of 88 per cent for a much longer period and has the additional advantage of possessing a reflectivity of 60 per cent in the ultra-violet region, where silver drops down to less than 10 per cent. In the Massachusetts Institute of Technology has been devised an apparatus for aluminizing large reflectors and already a number of mirrors belonging to Harvard Observatory has been

successfully treated. The operation is carried on in a high vacuum stainless steel tank housing filaments from which the aluminium is evaporated. The tank used has a volume of 175 cu. ft. and stands 9 ft high. A vacuum of 10^{-5} — 10^{-6} mm. of mercury is maintained inside the tank with the aid of diffusion pumps and mechanical fore-pumps. Evaporation is carried out from seventy-two tungsten filaments charged with aluminium which are arranged on the periphery of the glass disc which must be carefully cleansed. The distance of the discs above the mirror is adjusted so that a film of uniform thickness is produced. The operation takes from two to four hours during which time the high vacuum has to be maintained.

New Technical Institute in Delhi

In 1937, Mr A. Abbott, C.B.E., formerly His Majesty's chief inspector of technical schools, Board of Education, England, and Mr S. H. Wood, M.C., director of intelligence, Board of Education, England, were invited by the Government of India to advise on certain problems of educational reorganization, particularly in relation to the question of vocational education.

In pursuance of one of the main recommendations of the Abbott-Wood Report the Government of India have decided to convert the existing Government High School and Commercial Institute at Delhi into a Technical Institute.

The proposed Institute will contain, in addition to an experimental Technical High School, provision for courses or classes in technical, commercial and art subjects for students already in or preparing to enter employment. It will provide for an annual intake of 60 pupils. The minimum age at entry will be eleven and the normal length of the course six years. For the first three years the curriculum will be of a general character and similar to that followed in a good middle school so that at the end of this stage it may be possible to make transfers from and to schools providing the ordinary High School course. After this stage the curriculum will include a certain number of subjects of a practical character, *e.g.*, the properties of materials, the elements of engineering science, measured drawing and simple design. This second stage will last three years, the practical subjects occupying a progressively larger place during the last two years. It will be possible for the pupils in their last year to take a suitable school leaving examination without any risk of their course of study being unduly circumscribed by examination requirements. The object of the Institute will be to

offer its pupils facilities to cultivate an interest in the wider problems of modern industry rather than in the technical difficulties of particular processes, so that upon entering employment they will bring to bear an interest in their trades or professions not confined only to the office or workshop but embracing more comprehensive aspects, economic, technical or sociological.

On the recommendation of a selection committee set up by the High Commissioner for India, of which Mr Abbott, joint-author of the Abbott-Wood Report, was a member, Mr William Walter Wood, at present principal of the Mid-Essex Technical College of Arts, Chemsford has been appointed principal of the Institute.

Mineral Resources of the N. W. F. P.

THE North-West Frontier Province has an almost inexhaustible source of limestone and rich deposits of good quality white statuary marble and handsome banded marbles, according to Dr A. L. Coulson of the Geological Survey of India. The mineral production of the Frontier Province is extremely small and consists almost entirely of salt, limestone, marble and road material. There is, however, abundant power available from the Malakand Hydro-Electric Scheme and Dr Coulson thinks that every encouragement should be given to industrial enterprises wishing to take advantage of this power.

Discussing the possibilities of cement manufacture, Dr Coulson is not at all optimistic of a cement works in the Frontier Province competing successfully with the existing works in the Punjab.

The only known deposits of coal in the Frontier Province are in the Surghar range on the border of Kohat and Mianwali (Punjab) districts. Abundant deposits of gypsum are found untouched in the Kohat and Dera Ismail Khan districts.

The Attock slates occurring in the Peshawar district have been quarried in several places for use as a building stone. They might also afford valuable roofing materials. The acid volcanic rocks of the Mardan district offer abundant supplies of road metal which could have extensive use on local roads.

Peshawar, Mardan, Kohat, Bannu and the Dera Ismail Khan districts are greatly in need of schemes to develop their scanty resources of surface and underground water supply. Dr Coulson particularly advocates the impounding of flood water to the north of the Upper Swat Canal, to meet the increased demand for water, which is usual during September and October.

Geological Investigations in Assam

STUDIES in India's geology reveal the existence of thin seams of coal in the Khasi Hills region of Assam, according to a *Record* of the Geological Survey of India, just published. The coal bearing strata are in close association with the Sylhet limestone (Nummulitic) beds. These in turn overlie the Cherra Sandstones which elsewhere in Assam are known to contain large reserves of coal. In course of investigations it has been observed that this particular region of Assam had been the venue of important geographical changes resulting in the impoverishment and extinction of the specialised fauna of the Cretaceous seas.

On the Khasi Hills plateau a wide-spread stratigraphical and palaeontological break exists between the Cretaceous deposits and the overlying Cherra sandstones, which are, however, perfectly conformable to the superincumbent strata belonging to the Sylhet (Nummulitic) Limestone stage. It is therefore natural, observes the *Record*, that the Cherra sandstones should be regarded as the basal members of the Sylhet (Nummulitic) limestones and placed in the Tertiary (Kainozoic) era.

In the submontane tracts of the Khasi Hills, a passage (conformity) occurs which can be traced between the beds corresponding to the Cherra stage and the underlying Cretaceous strata. It seems therefore that at the close of the Cretaceous era the sea retreated southwards near Therriaghat leaving the northern plateau a land surface.

During the Eocene period that followed the sea made a fresh invasion of the Khasi Hills and submerged the major portion of the plateau extending a few miles north of Shillong. It was during this transgression of the sea that the littoral Cherra sandstones of the plateau area together with the overlying Sylhet (Nummulitic) limestones and coal were deposited.

South Indian Epigraphy

471 STONE inscriptions and 13 copper plate grants belonging to the several ancient South Indian dynasties and some other objects of archaeological interest were collected during the year 1936-37 from the Madras presidency and the Bombay-Karnatak area. A full account of these finds is given in the annual report on South Indian epigraphy for 1936-37, which has recently been published.

91 photographs of objects of archaeological interest including certain rockcut sculptures at Pillaiyarpatti and Kunnakkudi in the Ramnad district were also obtained. A few sites containing

pre-historic and proto-historic remains in the Tinnevely and Chittoor districts were examined and burial urns and pottery were recovered.

In the South Arcot district some caverns with rock-cut beds known locally as the *Panchavarparai* were discovered. These are similar to those found in the Pandya country and attributed to the 3rd century B.C.

Of the inscriptions collected in the Madras presidency, the earliest are four Brahmi records going back to about 3rd century A.D., recovered from certain ancient Buddhist sites in the Guntur district. Two of these belong to the Ikshvaku Kings, Vira Prisadata and Ehuvala Chantamula, who ruled in the Krishna valley and who were responsible for the splendid Buddhist monuments of Nagarjunakonda.

Of two inscriptions recovered from Srirangam near Trichinopoly, one records the establishment by a Heysala general of the 13th century A.D. of a dispensary as an annexe to the Ranganatha temple. The other mentions the consecration in the place of an image of Dhanvantari, the Aesculapius of the Hindus. In a memorial tablet of the 16th century A.D. engraved on a *gopuram* at Srirangam is related the story of how a Vaishnava devotee at Srirangam gave up his life by jumping from the top of a *gopura* as a protest against the stoppage of temple worship. Two South Kanara epigraphs of the Vijayanagari kings, Bukka and Devaraya II, in the 15th century A.D. have been found recounting royal endowments for the proper maintenance of a library attached to the well-known *matha* at Sringeri in Mysore State.

Technical University for India

It is understood that the Reorganisation Committee of Thomason Civil Engineering College have recommended for converting the College immediately into a statutory and autonomous technical university. Other provinces, administrations including Central Government and Indian States, that do not possess engineering college of their own, would be invited to take advantage of the training available in the Roorkee College on such terms and rules as the Government may approve.

They have further suggested that the following courses should be introduced in the syllabus of studies of the present civil engineering class:— (i) photography; (ii) aerial photography; (iii) explosives, (iv) industrial psychology; (v) engineering economics. The College should be developed as a centre of training in all branches of engineering and

with that object in view and in order to utilize its current resources the following branches of engineering should be opened at the College: (1) electrical, including hydro-electric engineering, (2) mechanical, including automobile engineering, (3) aeronautical engineering, (4) wireless (radio) engineering, (5) chemical engineering, (6) military engineering. The Committee are of opinion that immediate steps should be taken to implement the recommendation with regard to the military engineering and aeronautical engineering. In addition to the above, an architecture class has been recommended for producing qualified architects; and also an elementary course in architecture as a compulsory subject of study for civil engineering students.

The Thomason College was started in 1846 as a small establishment with three classes to train engineering subordinates to be employed in the construction of the Ganges Canal. The College steadily grew and was enlarged especially on a scheme prepared by Mr Thomason.

There have since been many reorganisation of the College, the first committee sitting in 1856, on the recommendations of which classes were expanded. By 1870 great changes had taken place in the College; further reorganization took place in 1897. From 1920 onwards the College reverted to specializing in civil engineering and abolished the mechanical and electrical classes.

Scientists Honoured

THE new year's honours list this year contains the names of several eminent scientists and scholars both in the United Kingdom and India. Prof. E. V. Appleton, secretary to Department of Scientific and Industrial Research in Great Britain is the recipient of a Knight Commandership, Dr R. T. Leiper, director of parasitology, London School of Hygiene and Tropical Medicine has been made a Companion of St. Michael and the list of new Knights includes the eminent physicist Prof. W. L. Bragg. Among the new Indian Knights are included two eminent scientists, Brevet-Colonel R. N. Chopra, professor of pharmacology and director, School of Tropical Medicine, Calcutta and Dr S. S. Bhatnagar, director of the newly created Board of Scientific and Industrial Research in India. Their contributions to the cause of science in India are well known. We note with pleasure that both of them have been connected with SCIENCE AND CULTURE for several years as editorial collaborators. We offer them our congratulations for the recognition of their services by the State. We are also glad to note that Prof. George

Gilbert Murray, the eminent scholar and chairman of the League of Nations Union has been awarded the Order of Merit and Dr S. N. Das Gupta, the author of several well-known treatises on Indian philosophy has been made a C.I.E.

Indian Science Congress Association

At the annual meeting of the general committee of the Indian Science Congress Association held in Benares on January 6, Mr D. N. Wadia, mineralogist, Ceylon Government, has been elected president for the 29th session of the Indian Science Congress, which will be held at Dacca under the auspices of the University of Dacca from the 2nd to the 8th January, 1942.

The following were elected presidents for the different sections:—

Mathematics and Statistics—Prof. P. C. Mahalanobis, professor of physics, Presidency College, Calcutta ; *Physics*—Prof. B. B. Ray, Khaira professor of physics, Calcutta University ; *Chemistry*—Dr M. Qureshi, head of the department of chemistry, Osmania University, Hyderabad, Deccan ; *Geology*—Dr Raj Nath, head of the department of geology, Benares Hindu University, Benares ; *Geography and Geodesy*—Mr George Kuriyan, head of the department of geography, Madras University, Madras ; *Botany*—Dr N. L. Bor, forest botanist, Forest Research Institute, Dehra Dun ; *Zoology*—Dr H. S. Rao, assistant superintendent, Zoological Survey of India, Indian Museum, Calcutta ; *Entomology*—Mr D. Mukherji, Zoological Laboratory, University of Calcutta, Calcutta ; *Anthropology*—Dr M. H. Krishna, professor of history and director of archaeological research, Maharaja's College, Mysore ; *Medical and Veterinary Research*—Dr C. G. Pandit, King Institute, Guindy, Madras ; *Agriculture*—Dr Nazir Ahmad, director, Cotton Technological Laboratory, Matunga, Bombay ; *Physiology*—Prof. B. T. Krishnan, professor and head of the department of physiology, Medical College, Madras ; *Psychology*

and *Educational Science*—Dr G. Pal, department of psychology, Calcutta University, Calcutta, and *Engineering*—Mr. H. P. Philpot, principal, Engineering College, Benares Hindu University, Benares.

Acknowledgments

We have received the following *Bulletins* of the new series from the Director of Industries and Commerce, United Provinces, containing information useful both for the technician and the layman.

(1) Washing and Dyeing of Silk Fibre (in Urdu)—No. 3 ; (2) Washing and Dyeing of Wool Fibre (in Urdu)—No. 4 ; (3) Wooden Toys—How to make them, No. 5 ; (4) Power Alcohol—Its use as Motor Fuel in the United Provinces, No. 6 ; (5) Some Indian Indigenous Dyes and their Application, No. 7 ; (6) Kamela and Pomegranate Rind Dyes—(Their fast dyeing on Wool and Silk), No. 8 ; (7) Development of Raw Hide Trade (Flaying, Preserving and Curing of Hides), No. 9 ; (8) Scheme for Educated Unemployed : Oil Industry ; Soap Manufacture ; Hand Made Paper ; Ghee and Butter Manufacture, No. 11.

We have also received from the Department of Industries, Government of Bengal, Bulletin No. 87 on '*Hosiery Industry in Bengal*'. This gives a review of the present position of the industry after tracing the initial stages and has concluded with a survey of the organisation of the same industry in Japan.

We thankfully acknowledge the receipt of the following:—

Journal of Osmania University (Science Faculty) Vol. VII and VIII of 1940 ; and

Technological Research Memoir No. 1—A Technique for Spinning Yarn samples from small quantities of Fibre ; *Agricultural Research Bulletin No. 1*—A Review of Agricultural Investigations on Jute in India—both from the Indian Central Jute Committee.

SCIENCE IN INDUSTRY

Lignin from Soda Black Liquor

ONLY about 50 per cent of the wood is utilized in manufacturing pulp for paper. The other 50 per cent is either discharged as waste, as in the sulphite process or is incinerated for the recovery of caustic from the black liquor as in the kraft and soda processes. This 50 per cent of the wood that is wasted contains 25-30 per cent lignin and 20-25 per cent hemicelluloses and other soluble low molecular organic compounds.

This lignin fraction has captured the imagination of the chemists for years. From an industrial standpoint lignin holds vast possibilities. It has been predicted that lignin may some day become so valuable that it will form the main product from the digestion of wood, with the pulp only as a by-product.

Lignosulphonic acid prepared from sulphite waste liquor is being used as a source of vanillin, as a tanning aid, as a plasticizer in cements, for water softening, and in soaps. Mead Corporation, Chillicothe, Ohio, has been carrying on intensive investigations to recover lignin from soda black liquor and the result is the "Meadol", the first pure lignin material to become commercially available. It is insoluble in water, is readily soluble in organic solvents, has decided plastic properties, and is chemically reactive. *Industrial and Engineering Chemistry* (p. 1399, 1940) contains an exhaustive account of this new product, a summary of which is given here.

It is prepared by precipitating spent soda black liquor with carbon dioxide. The precipitate, which is about 30 per cent of the total organic matter in the black liquor, is filtered and the filtrate returned to the evaporators and eventually to the incinerator for recovery of the soda ash. The filter cake is washed with dilute sulphuric acid and with water and is then dried on a drum drier.

Meadol is insoluble in water and in dilute mineral acids, soluble in dilute alkalis, readily soluble in most polar organic solvents, and insoluble in nonpolar organic solvents. It has a definite

melting range.* The greatest potential use of Meadol at present is in the moulding field. It can be used as a thermoplastic binder as well as modifying agent for thermosetting resins. Another important outlet for Meadol is as an expander in the negative plate of storage batteries. It is also being tried for other uses, such as for conditioning boiler water, for iron removal of water, for hydrogenation, and for use in paints and ceramics. Its low cost, being available in large amounts, gives promise of its further development to suit various industrial uses.

N. K. S. G.

Metallic Films as Lubricant

FOR the high vacuum demanded by X-ray tubes ordinary lubricants such as grease or oil are out of question since any vaporization of the lubricant will spoil the vacuum and render the tube useless. It has been recently announced by the engineers of the General Electric X-ray Corporation, Chicago, that a thin coating of metallic barium is very efficient as lubricant in such cases. They are using it in a special type of X-ray tube, in which the target is rotated at a very high speed. By vaporizing metallic barium a very thin film is allowed to form on the steel ball bearings of the rotating target and it has been found that this film greatly reduces the friction. Use of barium as lubricant has made possible a tube which not only has a much longer bearing life but also runs very quietly. In one of the experiments, the engineers reported, an anode bearing was observed to have a sound level of 87 db, a speed of 3100 r.p.m., and a coasting time of 12 seconds. A barium film was then applied, and in 30 seconds the sound level was reduced to 68 db, the speed increased to 3500 r.p.m., and the coasting time extended to 8 minutes. A number of other metallic films were found to have possibilities as lubricants, but barium proved to be the most successful.

It is expected that the process will be applied to other cases in which rotating devices have to be operated in vacuum. Further, such metal films may

find practical applications to rotating devices where organic lubricants are undesirable.

N. K. S. G.

Glass Reinforcement for Concrete

IN a recent issue of the *Engineering* a novel proposal to use strips of glass instead of steel rods or bars for reinforcing concrete has been described. The process has been developed and patented by two London architects and the specimens produced have been tested at the Structural Laboratory of the City and Guilds College, South Kensington. Glass strips used were from not of any special quality glass but were made from ordinary glass sheets, simply the surfaces were more or less wavy and not polished like plate glass. Test specimens showed that failure occurred suddenly and was of the type usually obtained with brittle materials. On reaching the maximum load complete collapse occurred, as distinct from the failure of the steel-reinforcement concrete with which complete collapse does not occur until some time after the maximum load has been reached. The impact tests compare unfavourably with the ordinary steel-reinforced concrete.

Test reports indicate that for static loading glass makes a suitable reinforcement for concrete, being a good substitute for steel, but that it should not be employed in cases where there is any likelihood of impact loading. The feature of the tests has been the consistency of the behaviour of the material, only one reject having been obtained in the whole series. Apart from the inability to resist impact the safe resistance moment is also somewhat low. The tests were undertaken with the idea of using glass in the construction of air-raid shelters, thus reducing the heavy demands for steel. But with the air-raid shelters impact loading being the likely conditions glass reinforcements cannot be used. Further investigations are proceeding and no conclusive evidence can now be given as to the value of glass as reinforcement. Much more exhaustive tests would have to be carried out before it can be universally adopted.

N. K. S. G.

Designs for War-time Safety

ALTHOUGH centralization is the key-stone of industrial efficiency, wide-spread decentralization is imperative for reduction of risk of attack from air. Plant security must be paramount, power-house and water-works must be far removed, and buildings in general should be of less geometric or cubical design which cast straight-cut shadow easily recognisable

from the air. The buildings should preferably be low, spaced apart from one another and their contour lines bent in various forms and curves. The glass of windows should be angled downwards to avoid light reflecting from them upwards. The colour should be duller and more or less matching with the surroundings. The roofs are often painted green or covered under leafy foliage, even strips of cloth and leaf-covered nets have their uses. Under-ground shelters as well as factories are also necessary to build.

K. R.

Human Limitations to Speed

It is the change of speed, not the speed itself, that affects our nerves. A smoothly running car would not make us feel anything unless we look outside at the objects passing off behind. It is the jerk and turn, both of which mean a change in speed, or the speeding up during start or slowing down at the stop, which affect our sensation. The same is the reason for sea sickness (due to rolling and pitching of the ship), or for the peculiar sensation in the lift-cage or on the merry-go-round. A constant unchanging speed has no such effect on our nerves. The earth moves on in its orbit with a tremendous speed of $18\frac{1}{2}$ miles per second without any of us feeling about it. The change of direction however is too small (less than 1° per day) to be appreciated by our system.

The idea of rocket flight captured the attention of scientists for exploring into the space, and many interesting and fantastic stories of rocket journey to the moon and Mars have since been written by successful writers. There is however a limit to its capacity conditioned by the sensation to be borne by the occupier. The rocket has a chamber containing explosive powder near its tail. As the powder burns, the explosion escapes through the tip of the tail, giving the rocket a forward thrust. As the process goes on, the rocket gains in speed. But as mentioned above, the rate of gain in speed (acceleration) should not be too high, or the passengers in the rocket will go out of breath. From actual experiments carried out by the German Rocket Society, it is found that maximum acceleration that human system can withstand is four times gravity, i.e., 128ft./sec.^2 . It is generally agreed however that the maximum acceleration that the passengers in a rocket could be expected to endure is 32ft./sec.^2 , and this acceleration endured for only 5 minutes would attain a speed of 6,000 miles per hour. Similar considerations are balking the work of aero-engineers planning to speed up the air flights.

K. R.

Information About Teak Plantations

INFORMATION of use alike to the trade and to those interested in forestry is given in a compilation on yield of teak plantations, just brought out by the Forest Research Institute, Dehra Dun, in its *Indian Forest Records*. Data on the rate of growth of teak in plantations throughout India and Burma are being collected for the last 25 years, and the present publication is the first attempt at a comprehensive yield table for teak plantations throughout India and Burma. The data for these tables have been collected from small sample plots in plantations of all ages and on every kind of soil from the worst to the best. These plots are remeasured every five years and are tended and thinned according to the best known practices, and when sufficient data have been collected, they are combined and compiled into a yield table. In the present publication the tables have been made up from data from 753 remeasurements in 387 plots.

The tables provide all the necessary statistics for the proper management of teak plantations. They tell one for every age and for every different soil quality how many trees there should be per acre, what the height and diameter of the trees should be, how great the yield of timber and of firewood should be if the plantation is to be felled at different ages, what the current annual rate of increment is, and also the mean annual increment, and so on. They provide the fundamental statistics for determining the most paying age to which plantations should be grown, and set standards for the stocking of the crop and thinning which are an invaluable guide to any one who has to manage teak plantations and desires from them the highest financial returns. The existing teak plantations are now estimated to cover an area of roughly 300 square miles, and about 10 square miles are being added annually in India and Burma.

Shellac Floor Varnishes

It is estimated that some 12,000,000 lb. of shellac, mostly prepared from seedlac imported from British India, is consumed every year in the United States of America for the preparation of floor varnishes, according to a bulletin issued by the London Shellac Research Bureau. A dozen factories are busy all the year round bleaching the seedlac to get rid of the natural orange red colour of the material.

In America, where wooden floors are in almost universal use, the best methods of polishing such surfaces with the minimum of work involved in daily cleaning and general maintenance attracted con-

siderable attention. The method which is now widely used is the application of spirit shellac solutions. These have resisted the competition of substitutes because of the cheapness of materials from which they are made (shellac and industrial alcohol), ease of application, durability, simplicity of renewal and care-free maintenance.

The bulletin describes practical tests made in the headquarters of the New York Shellac Bureau, where a floor used by some 1,800 people every day and composed of different woods, was cleaned with various floor finishes. The test resulted in a rating of 80 per cent perfection for shellac for all woods.

Tung Oil Yielding Trees in India

FROM the data gathered hitherto from many sources Dr K. Biswas, superintendent of Royal Botanic Garden, Calcutta announced at a meeting of Royal Asiatic Society of Bengal that there was sufficient prospect of successful cultivation on a commercial scale, of tung oil trees, particularly *A. Montana* and *A. Moluccana*. They can be grown in the village shrubberies, in the different tea estates for plantation purpose or as shade trees and along the portions of the hill-sides which are not productive enough for other profitable plantations. Viable resistant seeds yielding larger quantity of oil may be obtained from experimental cultivation which may conveniently be undertaken by the forest department in suitable areas. The various uses of the tung oil are in connection with the electrical industry, in the manufacture of oil cloth, water-proof articles, chinese ink, etc. It is invaluable in the manufacture of paints and varnishes.

Half a century ago three species out of the known five species of tung oil trees were first introduced to the Botanic Garden here. Tung oil yielding trees belong to the genus *Aleurites* of the family of Euphorbiaceae. In 1931 about half a ton of seeds was received from the Royal Botanic Garden, Kew. These were distributed to the different provinces of India for experimental cultivation in order to ascertain which part of the country proves more favourable for their cultivation. Records of successful cultivation are available from the Indian Lac Research Institute, Ranchi; and Sabya Division, Ranchi. The Bhoota-chang Tea Company Ltd. have also been very successful in the cultivation of both *A. Fordii* and *A. Montana*. The Mysore State in South India also cultivated the tung oil yielding tree with success.

The results of cultivation in the different parts of the country during the last decade indicate that *A. Montana* is more vigorous and disease-resistant species. It can be grown easily in well-drained soil

along the hill-side from an elevation of 1,500 to 4,000 ft. with considerable success. The yield of the fruits is also much higher than that of *A. Fordii*. *A. Moluccana*, as experiments for the last so many

years in the Botanic Garden show, is another hardier species which is expected to grow easily under the soil and climatic conditions of the plains of Bengal, Bihar, Assam and South India.

Cool Light

The idea of light is always associated with heat. Whenever one thinks of a light-source, one knows that the source is at a high temperature. Along with light, heat waves are also being emitted by it. In fact, a heated source radiates energy in all forms—electrical, heat, light, ultraviolet, etc.—having different wavelengths. The portion of radiation between the wavelengths 4000 to 7000 Å (one Angström, $\text{Å} = 1 \times 10^{-8}$ cms.) produces visual sensation and is called light.

If the whole of the energy emitted by a heated source be only the visible radiant energy, the light so obtained, being unaccompanied by heat or other waves, may be called a "cool light", having a luminous efficiency of hundred per cent. Strictly speaking the term "cool light" is relative, since the visible radiant energy which through the agency of vision becomes light, produces a heating effect when absorbed, just as invisible radiant energy does. The coolness of light is an essential factor when very high levels of illumination are necessary, e.g., in television, and night working of factories.

The levels of illumination which can be obtained with comfort are limited by the resultant coolness of foot-candles supplied to the user of light. The luminous efficiency of a light source is a partial measure of the coolness of the emitted lumens. A luminous efficiency of 621 lumens per watt would be attained if all the energy supplied to a light source were converted into radiant energy of 5550 Å. This is the wavelength of energy which human vision converts into maximum luminosity under ordinary levels of brightness. But this would be a light-source emitting only monochromatic yellow-green light which would not be suitable for most lighting purposes. A far more desirable light-source would be one which supplies white light without being accompanied by any invisible radiant energy. To obtain such a light, the colour temperature of the source should be assumed as 6500°K. (the surface temperature of the sun) which will give a light similar to that of average daylight during midday. If such a light-source radiated all its energy in the visible spectrum, with blackbody distribution between 4000 and 7000 Å, its maximum

luminous efficiency would be 225 lumens per watt. This may be considered the ideal light-source, as far as coolness of lumens and foot-candles are concerned.

The relative coolness of the light from a number of different sources, based on their relative energy per foot-candle, as measured by M. Luckiesh and A. H. Taylor at the Lighting Research Laboratory, of the General Electric Company, Cleveland (Ohio), and reported in the *General Electric Review* (p. 410, 1940) are given in the table below:—

ENERGY PER FOOT-CANDLE FROM VARIOUS LIGHT-SOURCES

Relative Coolness of Foot-candles.

Source	ENERGY PER FOOT-CANDLE		RELATIVE COOLNESS	
	Micro-watts per sq. cm.	Relative Energy	A†	B*
Monochromatic energy at 5550 Å	1.73	1.0	100	—
Firefly	2.1	1.2	82	—
Ideal white light (6500°K.)	4.8	2.75	36	100
Clear skylight through ¼ in. window glass	4.9	2.8	35	98
Noon sunlight	9.0	5.2	19	53
Noon sunlight through ¼ in. window glass	7.5	4.3	23	64
Water-cooled mercury lamp (Type H-6) in aluminium reflector	4.0	2.3	43	120
40-watt white fluorescent lamp, bare	8.0	4.6	21	60
40-watt white fluorescent lamp through ¼ in. window glass	3.5	2.0	49	135
40-watt fluorescent daylight lamp, bare	10.0	5.8	17	48
40-watt fluorescent daylight lamp through ¼ in. window glass	4.5	2.6	38	107
60-watt tungsten lamp, bare	55.0	32.0	3.1	8.5
100-watt tungsten lamp, bare	45.0	26.0	3.8	10.5
200-watt tungsten lamp, bare	40.0	23.0	4.8	12.0

† A : Relative to monochromatic energy, 5550 Å.

* B : Relative to ideal white light 6500°K.

A study of the data in the table, particularly in the last column, reveals great achievements in the production of cool light. Actually in some cases the light obtained is cooler than the ideal white light. Though coolness depends on luminous efficiency, it may be further increased by means of extraneous agencies, which will absorb or reduce the radiant heat energies accompanying the lumens or foot-candles.

In the case of the water-cooled mercury lamp, the relative coolness with respect to white light is 120. The luminous efficiency of 1000-watt water-cooled mercury lamp is 65 lumens per watt and more than two-thirds of the energy, accompanying the light as other waves, is absorbed in the water used to cool it, and moreover the light is not white but rather a bluish white, with a deficiency of red.

The 40-watt daylight and white fluorescent Mazda lamps at present supply foot-candles as cool as those due to noon sunlight. Actually the luminous efficiency of 40-watt fluorescent daylight lamp

is approximately one-fifth that of the ideal white light, but the method of light generation used in the fluorescent lamp is such as to make the light cooler than would be indicated merely by the luminous efficiency rated in terms of energy input. Because of the large surface area fifty per cent of the energy input is dissipated by convection currents in the air. Furthermore approximately 55 per cent of the energy radiated by the fluorescent lamp is in the form of long wavelength—infrared from the heated tube—and this can be entirely absorbed by a sheet of ordinary glass interposed between the lamp and the user of light, thus increasing its coolness.

Incandescent filament lamps have a very low luminous efficiency. Their luminous efficiency and the colour of the light are limited by the highest temperature at which the filament could be operated without too rapid evaporation. Approximately 90 per cent of the energy accompanies the lumens as compared with less than 50 per cent for the fluorescent lamp.

N. K. S. G.

The Industrial Significance of Jute Research*

W. G. MACMILLAN

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MANY of you must have seen during the past year numerous articles in the press regarding the necessity for research in the development of India's industries, and attention has frequently been drawn to the necessity of developing new uses and finding new outlets for jute and jute manufactures. Circumstances which have arisen as a result of the war have made it imperative that present needs be treated as of first importance, and I shall endeavour to show the vital necessity for research in any industry and how the jute industry has responded to the immediate demands made upon it and, at the same time, is looking to its future in the development of research.

Before doing so, however, I would like to give you a general idea of the position which research occupies in this country. Throughout India there

are numerous public and private research organisations, each concerned with its own individual problems, or the problems of the industry which they happen to serve. In addition, certain provincial governments have set up their own boards, whose concern is the welfare and expansion of the industries in their own particular province, and such is the case in Bengal. Again, there has been established during the past year a Board of Scientific and Industrial Research, financed from Central Government funds, whose principal function is to co-ordinate research towards creating a new and expanding future for industry in this country. The very fact that these different organisations exist, supplemented by the researches which are carried out at universities and colleges, is a definite sign that a forward policy is being pursued in India today which must inevitably bear fruit. The commercial potential of the natural products and resources of this country is enormous, but for successful development complete co-operation must exist between the

* Adapted from a lecture delivered before the Calcutta Rotary Club on December 10, 1940.

industrialist and the scientist. Only when this is obtained will the expansion of established industries and the creation of new ones proceed with an ever increasing momentum.

SCIENTIFIC RESEARCH FOR INDUSTRIAL PROSPERITY

Many authorities regard the expenditure on research, either in a country or by an industry, as a definite sign of future prospects and prosperity, and the rapid development of certain industries following the industrial upheaval after the war of 1914-18 are striking examples of this fact. Such industries include the automobile industry, radio, plastics, synthetic fibres, dyestuffs and chemicals, and others too numerous to mention. The case of nickel is worth quoting specifically. The armament demand for this metal almost vanished twenty years ago, but the industry was so successful in its search for new applications and uses that, during the intermediate period prior to the outbreak of the present hostilities, the armament demand, which was even greater than ever, no longer occupied a large part of the market. The skill and ingenuity of German chemists has always been recognised by scientists throughout the world, and it is only through her highly developed and organised chemical and other industries that she is a force to be reckoned with in international trade and commerce during times of peace, and a formidable opponent in time of war. The commercial exploitation of the Haber synthesis of ammonia from nitrogen and hydrogen at high pressures, with the aid of suitable catalysts, and upon which millions of pounds were spent, enabled Germany to carry on a struggle for four and a half years as a result of her independence of foreign supplies of nitric acid, which is the basic chemical for all ammunition industries. Today, when oil is as important as munitions, in that the two are complementary in modern mechanised warfare, a parallel case exists. The production of synthetic petrol from coal and water-gas of which Germany has large resources, and crude oil which she is attempting to control in the Balkan and other States, by hydrogenation processes such as the Fischer-Tropsch, has once again reduced her dependency on imports of the natural product. The achievements of British industry during the past twenty-five years through the advances made by its research workers have been admirably summed up by the late Sir Gilbert Morgan in his series of Cantor lectures delivered before the Royal Society of Arts in 1939, while the products of American research and invention will become evident in the ever increasing supply of war materials to assist the British Empire in bringing the war to its inevitable successful conclusion. One must also not forget the rapid industrialisation of Japan through co-ordinated effort

which has proceeded at an astonishing and at times almost alarming rate during the past twenty years.

Looking at the reverse side of the picture you can also see how an established industry dependent on the natural product of a country can be irretrievably lost unless adequate provision is made to develop and protect it against competition from substitute or synthetic products. The indigo industry in this country has provided such a case and also a warning which should not be neglected. As a result of the combined researches of German chemists, extending over many years, the Badische Anilin & Soda Fabrik combine were able to produce a synthetic product from naphthalene, a cheap and readily available by-product. This synthetic product, which could be readily standardised when placed on the market, almost eliminated completely the demand for natural indigo and in consequence a very large source of revenue to the country was lost.

IMPROVED USES OF JUTE

Turning now to the jute industry itself. Jute fabrics have been aptly termed the world's foremost packing materials and in this respect have held almost a monopoly for close on eighty years. Probably however as a result of this monopoly the industry has for many years lagged behind other textiles in research. Profits were good and the industry continued to expand but the world-wide depression of the early '30s was a sign that although Calcutta enjoyed great material advantages it was essential to keep up to date and apace with competition. Silos to store wheat, paper cement bags and the problem of jute substitutes, about which I shall say a little later, showed how the wind was blowing and plans for research to deal with jute's own special problems were therefore enthusiastically supported. The results of the wide researches which are being conducted both in the raw material and manufacturing sides of the industry, and as yet still in their infancy, can be reflected in the supply of jute materials for war purposes where much recently acquired data has been found capable of direct application. As examples may be mentioned the following:—

(1) *Cotton/Jute Union Fabric.* This fabric is being manufactured and used as a substitute for materials formerly made from flax, the supplies of which have been reduced to almost negligible proportions as a result of the war. It contains a cotton warp and a jute weft and can be made to a variety of cloth specifications which have given excellent results on preliminary tests for service use. The possibilities of its adoption for the manufacture of canvas for tarpaulins, tentage fabric, water tanks, hose pipes etc. are great, and in addition it has been found

eminently suitable for the application of finishing processes such as waterproofing. As a result fresh outlets for two of India's principal agricultural commodities have been found.

(2) *Sandbags and Rotproofing.* The jute mills in India have supplied 912 million sandbags for war purposes, and a further order recently announced, will increase this figure by six crores or sixty million. A jute sandbag is similar to one made from any other vegetable fibre in that it is liable to attack by micro-organisms under certain conditions, such as damp, and can in exceptional circumstances deteriorate rapidly. The growth of micro-organisms can be inhibited or completely prevented by—

- (a) reducing the moisture content to the required maximum which, for jute, corresponds to a regain in the neighbourhood of 17 per cent.
- (b) impregnating the fabric with substances toxic to micro-organisms, and
- (c) rendering the fibres unsuitable as a medium for the growth of micro-organisms.

The first of these is obviously not possible under conditions of use, and only the latter two principles are practicable.

Rot-preventing substances of known toxicity towards fungi and bacteria, and which are particularly suitable for application to jute and other vegetable fibres include *inter alia* miscellaneous organic compounds, tar distillates and the metallic salts or soaps of certain metals, such as copper, zinc and mercury. It is important to remember, however, that a good fungicide is not necessarily a good bactericide and vice versa. The methods of application involve the use of emulsions or solutions in appropriate diluents and containing the requisite concentration of the rot-inhibitor. The toxic compound may also be formed on and in the material by chemical reaction such as, for example, by the interaction of copper sulphate and sodium carbonate to produce basic copper carbonate.

The third principle is based on partial esterification of the jute as the result of acetylating or benzoylating the fibre surface. The immunity obtained is excellent but the cost is at present prohibitive for jute. These methods are embodied in various patents and it is claimed that no deterioration of the colour, handle or any other characteristic of the fibre need be obtained.

(3) *Waterproofing.* The demand for light, medium and heavy water-proof textile materials has greatly increased. In consequence special proofers have been developed to yield different types of waterproof finish which can, if necessary, be supplied in a variety of colours.

The principal water-repellent materials used are waxes and oils of petroleum origin but various concoctions of pitches, asphalts, wax tailings and many other resinous and water insoluble organic materials may be used. More expensive proofers involve the use of rubber, special synthetic resins and permanent sizes. Application of the proofing materials is either by impregnation or surface treatment. The former is commonly used on heavy ducks and canvas for tarpaulins, hatch and cargo covers, etc., the fabric being impregnated with sufficient waterproofing compound to effectively saturate all the yarns therein completely, or the surface is coated with a compound that covers completely and so fills all the small openings in the fabric. Coated or surface treatments involve the application of a continuous unbroken film of wax or waterproofing compound closing all the pores thoroughly, and can be applied to cheaper light weight drills, twills and ducks used for stationery covers, flys and so on.

(4) *A. R. P. Fabrics for Blackout Purposes.* A source of supply of cheap and serviceable blackout materials which are completely resistant to the passage of light has become necessary. Experiments recently conducted have produced a variety of such types of materials which can be made available in bulk in any desired quantity. The methods employed include the use of special bitumens to give "lino" finishes, black wax treatments, proofing with latex and the doubling of paper on to dyed hessian with suitable adhesives.

(5) *Camouflage Materials.* In the utilisation of jute fabrics for defence purposes, such as camouflage, it is essential that these should be treated in such a manner as to yield as far as possible bright colours which are fast to light, weathering and washing. The strength of the jute must not be weakened by the processes used and, for external use, particularly where exposure to excessive moisture would ensue with alternate wetting and drying due to weather conditions, it is necessary to introduce a toxic substance to minimise the effect and risk of rotting and decay. The treated fabrics must also be able to defy identification by aerial reconnaissance. Rolls of hessian strips, dyed in different colours, and running into millions of yards, have already been supplied for camouflage purposes.

(6) *Hessian in Road & Aerodrome Construction.* The ever increasing flow of heavy transport on roads, and the expansion of aerodromes and runways, have necessitated the consideration of methods for improving their stability, increasing their resistance to wear and tear and facilitating surface replacement when this is necessary. One of the principal advantages of fabrics in road construction is that they form a cleavage line which enables a

ready and speedy replacement of a damaged road surface, and specially constructed and treated jute fabrics are at present undergoing test in this connection.

These then are some of the needs of the present.

It is however upon successful long distance planning and organisation that the real value of industrial research departments depends. They must never be allowed to become static. The value and economy of co-operative research is being increasingly recognised and the direction of research into definite and potentially productive channels is a matter of the greatest importance. It should always be remembered however that the scientist cannot direct an industry, he must receive his lead from the industry in order that he, in his turn, can direct and co-ordinate his work accordingly.

JUTE RESEARCH

I shall endeavour now to show briefly the nature and type of jute research being carried out in the Calcutta and London departments of the organisation with which I am connected. There are six main categories into which this can be divided.

FUNDAMENTAL RESEARCH

Under the above heading is classified research in pure science and purely scientific problems relating to jute. Initially this is what should engage the whole-time attention of any industry's research work if data is not already available since applied research cannot begin until there is something to apply. The boundaries of science are rapidly losing their significance and today there are countless examples of the results of one science being successfully applied to another. For example, many parallelisms have been found to exist between the fundamental chemistry of wool in the science of textiles and insulin which is also a sulphur-containing protein in the sciences of bio-chemistry and medicine. Similarly, with vegetable fibres, which include jute, the building up of starches and sugars from simple substances and a study of their reactions in the field of pure chemistry, the effects of soils, water, climate, etc., on plant growth in the field of agricultural chemistry and the structural anatomy of plants in the field of botany, are all closely interconnected in their underlying fundamental principles. The war and attendant circumstances have forced the pace on the practical side leaving much of this work to be tackled when day-to-day problems are less pressing.

RESEARCH INTO EXISTING PROCESSES

This is really self-explanatory and covers industrial research applied to the elimination of manu-

facturing troubles and to the improvement or standardisation of current methods based on sound scientific principles. The process of jute manufacture is largely dependent on engineering science but there are certain processes which form part of the standard system of manufacture and on the efficiency of which much depends. Amongst these may be included the oiling and sizing of jute. There is also the immediate need for finer spinning in view of the flax shortage, work on which will be conducted elsewhere. There may also be included special or *ad hoc* investigations carried out on behalf of individual mills regarding their own particular problems. This form of technical service has the additional advantage of providing and maintaining an excellent means of direct, continual and personal contact or liaison with individual units in the industry.

STANDARDISATION

In this category is included research for the purpose of establishing standard methods of test and standard specifications connected with the purchase of the raw material and the quality of the finished article. Two specific examples which are of very great commercial importance are worth citing.

Firstly there is the problem of moisture in jute. Since water cannot be made into cloth the presence of moisture over and above the natural content of jute represents a very large sum of money lost every year. This sum has been computed at not less than thirty lakhs of rupees in an average year. The necessity for the provision of reliable and accurate moisture standards for jute, along with a suitable means of assessing claims on a commercial scale is

TABLE I

	Standard Moisture Content	Standard Regain
Cotton	7.83	8½ Per cent.
Silk	9.91	11 " "
Flax and Hemp	10.71	12 " "
Jute	12.09	13½ " "
Wool and Waste	13.79	16 " "
Wool (Tops combed with oil)	15.97	19 " "
Wool (Tops combed without oil)	15.43	18½ " "
Worsted Yarns	15.43	18½ " "
Carded Woollen Yarns	14.53	17 " "
Wool Noils (ordinary)	12.28	14 " "
Wool Noils (scoured and carbonised)	13.79	16 " "
Woollen and Worsted Cloths	13.79	16 " "
Viscose and Cuprammonium	9.91	11 " "
Acetate Rayon	5.66	6 " "

obvious to all and will undoubtedly prove of very great benefit to all those interests in the trade whose desire it is to see a fair and reliable system introduced.

Regain values for different textiles issued in 1940 by the Standardisation Committee of the Textile Institute in Great Britain are shown in Table 1.

Recent researches in the various moisture relationships of jute have shown that the difference in hygroscopicity between the *Olitorius* and *Capsularis* varieties is insufficient to merit a distinction being drawn for commercial purposes.

In Table 2 is shown regain values for jute (after Pfuhl) taken at different humidities with the temperature constant (65°F).

industry and its products. Non-recurring complaints are special cases and result, more often than not, from external causes which are really no concern of the industry at all although the latter, in many cases, is expected to provide the remedy. Experience shows the ease of generalisation and condemnation of an entire commodity for isolated delinquencies and hence a knowledge and understanding of the nature of such complaints, followed by the necessary measures to safeguard against repetition, is of great commercial importance. Jute is very largely used on account of its relative cheap-

TABLE 2

Percentage R. H. of atmosphere	0	10	20	30	40	50	60	65	70	80	90	100
Regain, per cent	0	2	4	6	8	9.5	11.5	12.75	14.0	16	23	37
Weight of 16 ounces jute	14.19 (dry wt.)	14.47	14.76	15.04	15.32	15.50	15.82	16.0 (1 lb.)	16.17	16.46	17.46	19.44

Secondly, there is the question of standardisation of fabric specifications. This involves technical studies on the relationship of fabric performance to fabric construction and in view of the many uses to which jute manufactures are put the introduction of definite yarn and fabric specifications, based on standard methods of test, will ensure that the customer receives, and will continue to receive, a product suitable for his particular purpose, and so maintain the necessary confidence between supplier and consumer. The more important physical standards include fibre length, tensile strength, weight, count (warp and weft), twist, regain, elongation, crimp, thickness, length and width, tear resistance, yarn friction in fabric, evenness, resistance to abrasion, absorbability, bursting strength, heat transmission and porosity. On account of the inherent variability of jute yarns and fabrics it is absolutely necessary, in order to get a true interpretation, that a sufficient number of readings be recorded for the various tests and these submitted to a statistical analysis. The physical properties and constructions are changed according to requirements and service demanded of the materials. The U.S.A., for example, is the world's largest hessian consumer and has every right to be exacting, so that if a particular fabric with say a specified breaking strain, or a special fabric for particular purpose is required, it is up to the industry to co-operate in trying to give it.

INVESTIGATION OF COMPLAINTS

Complaints may be divided into two categories, namely, recurring and non-recurring. Recurring complaints are generally directly connected with the

ness compared with other materials, and in suggesting remedies for complaints the economic fact of cheapness has frequently to be uppermost since remedies which would greatly increase the price are ruled out on this account alone, in that the consumer either is unwilling to pay more, or that competitive materials would come within the now higher price range and perhaps be preferred. As specific examples of recurring complaints we have hair shedding in wool packs, the development of rancidity and discolouration due to unsuitable oils and stains due to attack by micro-organisms. The causes responsible for these are known and the necessary remedies available, so that it is really a matter of whether additional costs involved will be met by the consumer.

APPLICATION OF FINISHING AND CHEMICAL PROCESSES

Under this heading lies the future of new uses for jute manufactures. A very large literature exists on chemical and finishing processes generally and new types of finish and methods of finishing are continually being evolved. Hence it has not hitherto been found necessary to attempt to find something entirely new but rather to apply something that is old in a suitable manner so as to yield what might be termed a new jute product or a jute product for a new use. Specific examples of finishing methods have already been mentioned in connection with war demands. In the field of chemical processing may be included treatments to yield cottonised and woollenised jute which may be spun and woven in admixture with other fibres, such as

cotton and wool, to yield speciality yarns and fabrics. Such treatments have been the subject of many British and foreign patents and involve the use of combinations of numerous chemicals, among which may be included soaps, soluble oils, alkalis, hypochlorites and many others. I believe that the uniforms used by the French Army were largely composed of a mixture of jute and wool. In the field of bleaching the principal difficulties which have hitherto been found, namely, loss in strength and the poor colour of bleach obtained, have been successfully eliminated by a new method. The success of this bleaching method has opened up the whole future of dyeing jute in bright, clear and fast colours. A few years ago any mill process involving a wet treatment of jute as fibre, yarn or cloth was almost unknown, but today difficulties are being rapidly overcome and the range of jute's utility extended accordingly.

SUPPLY OF INFORMATION

A most important feature with regard to industrial research is the issue of information. Such information can conveniently be divided into three groups:

- (1) The publication of the results of purely scientific and academic researches in appropriate journals.
- (2) The submission of technical reports relating to process and manufacture.
- (3) The provision of information in the form of abstracts on all matters relating to jute and jute products, gathered from the journals of countries throughout the world. For this purpose the abstracts and information service of the Indian Jute Mills Association takes the form of a monthly publication in which the abstracts are classified individually under their appropriate headings. In the course of a year over six thousand issues of six hundred journals are read, and from these journals, which cover thirty countries, approximately 2,500 abstracts are made by summarising the original papers and translating from foreign languages.

SYNTHETIC FIBRES AND JUTE SUBSTITUTES

Finally, I would like to touch very briefly on the development of synthetic fibres and the problem of jute substitutes. The production of synthetic fibres, to which much recent publicity has been given, can be regarded as one of the greatest examples of combined chemical and engineering research that has ever happened and their phenomenal

development is a splendid example of the skill and ingenuity of chemist and engineer, combined with a superb marketing propaganda and sales organisation. These synthetic fibres, which have rapidly stepped up to a premier place amongst the textile products of the world, use for their raw materials such widely divergent substances as wood pulp in the production of artificial silk, now known as rayon and staple fibre; the soya bean, largely found in Manchuria, from which a new type of fibre has been developed; milk from which casein is obtained by coagulation methods for the production of synthetic wool; and coal, air, limestone and water which, through a series of chemical reactions, are converted into fibres of which the German PeCe fibre and the American nylon fibre are typical examples. One must also not forget that glass can now be spun and woven into fabrics. Germany, which was a large importer of jute, has this commodity now completely denied her, but her need for a cheap textile material has, to a certain extent, been met by the invention of a new fibre called Cell Jute, made from straw, and which can be used either alone or mixed with staple fibre as artificial jute. Paper tissues have also been converted into cheap substitutes for covering walls, etc.

As regards jute substitutes from naturally occurring fibres, this has largely arisen through the self-sufficiency policy followed by so many countries in recent years. The success or failure of these naturally occurring jute substitutes, which undoubtedly can be made into the equivalent of jute manufactures, is chiefly a matter of economics and the crux of the whole matter would seem to depend on the cost of the raw material and the production of the finished article, and to maintain these costs at price levels which are competitive with jute. Jute has all the advantages of centralisation, established practice, suitable soil requiring no artificial stimulant, plenty of water for steeping, retting and washing, an abundance of ready labour and on the manufacturing side a highly organised and technically well-equipped industry.

In conclusion I would like to quote a short extent from a speech recently made by the well known textile industrialist, Sir Kenneth Lee, whose firm has pioneered and developed so successfully the application of synthetic resins to textiles and produced the familiar range of "Tootal" uncreaseable fabrics. He said with reference to cotton—"We are an old industry, founded on rule-of-thumb methods. We do require different outlets, science certainly can give it to us, and its wholehearted adoption, in my view, is the surest means of ensuring a prosperous future."

These words carry their own portent.

MEDICINE & PUBLIC HEALTH

Anthracite Dust and Pulmonary Tuberculosis

It is believed that the inhalation of dust in coal mines tends to prevent phthisis. Cumins *et al* (*J. Hyg., Cam.*, 31, 464; *Brit. J. Exp. Path.*, 21, 64) observed that anthracite dust was capable of adsorbing a relatively large amount of tuberculin *in vitro*. Recently Cumin (*Brit. Med. J.*, 2, 623, 1940) tried to show if living tubercle bacilli could be adsorbed by anthracite dust *in vivo* in experiments with rabbits. Two groups of rabbits were taken. One group was intratracheally inoculated with a living emulsion of extremely virulent bovine tubercle bacilli and the other group was similarly inoculated with anthracite dust together with an emulsion of bovine tubercle bacilli. The rabbits of the latter group survived for considerably longer periods than the control rabbits. It is therefore suggested that the anthracite dust adsorbs a portion of the toxic products of living tubercle bacilli in the tissues.

S. B.

Benzyl Benzoate Treatment of Scabies

SULPHUR ointments and sulphur preparations are usually prescribed for the treatment of scabies. Ointments are usually dirty and tedious in application and all the sulphur compounds often produce dermatitis, a complication worse than the disease itself. Recently King (*Brit. Med. J.*, 2, 626, 1940) has treated 100 cases of scabies with benzyl benzoate with very good results. The method consists of the following procedures. The body is first anointed with soft soap. The body is then soaked for 10 minutes in a bath at 100°F. While the body is still wet a lotion consisting of equal parts of benzyl benzoate, industrial spirit and soft soap is applied vigorously for five minutes with a shaving brush. The lotion and the lather produced are allowed to dry on the skin. The lotion is then reapplied for a further 5 minutes and the body is dried with a towel and the patient is allowed to wear clothes. After 24 hours a bath is taken. 1½ oz. lotion is necessary to cure a case. The clothes are to be sterilised by boiling.

S. B.

Calcutta Corporation Laboratory

THE Central Laboratory of Calcutta Corporation has a historical importance due to its significant contribution to the control of cholera, plague and food adulteration. Recently new premises have been opened for the Laboratory when its history was narrated. It is expected that the scope of its work will be widened and some reference to it was made by Dr John B. Grant at the opening ceremony. "If the health work of Calcutta is to function efficiently, if the control of the water and milk supplies and of communicable diseases is to be based upon facts rather than personal opinion, and if the clinical service is to put into practice for its patients all our present-day knowledge of disease prevention, there must be available a public health laboratory doing work of such high character and broad scope that all workers in this field will instinctively seek its guidance and advice. . . . The laboratory should be so organized that it will be able to undertake as they are needed studies or research in special public health problems which may be peculiar to the locality." He further suggested that the service of a public health laboratory to the community should be free and available to the private practitioner, for the efficacy of curative medicine is proportionate to the earliness of diagnosis.

It is gratifying that the Mayor took the opportunity to stress the need for harnessing scientists and experts in a planned manner. Nearly all the problems dealt with by municipal corporations have three aspects, scientific, technical and organizational. He therefore emphasised that the number of advisory bodies should be increased and their personnel must consist of scientists and technical experts in a greater proportion. The advice given by these advisory bodies should not be treated as recommendatory, according to him. He would like to substitute personal opinions, of mainly non-experts who occupy a position of authority, by opinions based on painstaking study of the problems.

Laboratory's Control Measures

The Corporation Laboratory was organised by Dr W. J. Simpson (afterwards Sir William Simpson)

who was the first wholetime health officer of Calcutta from 1886 to 1897. Previous to this, professors of Medical College used to hold appointment as part-time health officers. In 1883 Professor Koch discovered *coma bacillus* (known as Koch's bacillus) in the intestines and the intestinal discharges of cholera patients in Egypt. Dr Simpson was in Egypt at the time of this discovery and closely collaborated with the latter when Koch came to Calcutta to test his Egyptian discovery. His Egyptian observations received complete confirmation from his Calcutta investigations and Koch was able to satisfy himself that the *coma bacillus* stood in intimate relationship with the production of cholera. Following on Koch's discovery came the researches of Professor Waldermar Haffkine which resulted in the discovery of cholera prophylactic vaccine which is now effectively used whenever there is an outbreak of cholera. Lord Dufferin, a former Viceroy of India, who was then the British Ambassador in Paris took a keen interest in Haffkine's researches and arranged that Haffkine should be given all possible facilities to visit every part of India to carry on his investigations. The Corporation Laboratory was placed unreservedly at Haffkine's disposal and Simpson deputed his able lieutenants including Dr J. N. Dutt and Dr S. B. Ghosh to assist Haffkine in his work and to learn from Haffkine the method of preparing the vaccines. The result of two years' (1893-94) inoculation and investigation showed that mortality among the inoculated as compared with that of the un-inoculated gave a reduction of more than 72 per cent.

When plague broke out in Bombay in September, 1896 Haffkine was there and with his characteristic thoroughness he set about finding a prophylactic vaccine for plague as he had already done for cholera. His investigations were carried on for a period of 10 years, the major part of his research being done in Calcutta Corporation Laboratory. The outbreak of plague in 1897 in Calcutta provided Haffkine and his co-adjutors materials for observation, and research and investigations were carried on assiduously, till in 1908 Haffkine was able to place before the Royal Society of Medicine the result of his researches.

There was another pioneer work which was carried out in the Corporation Laboratory, viz., the investigation regarding the purity of drinking water in Calcutta. In 1909 Major Clemesha, sanitary commissioner for Bengal was deputed by Government to study this question and for a whole year he worked in the Corporation Laboratory. As a result of these investigations, the underground reservoir at Wellington Square and Halliday Park (now called Muhammad Ali Park) were closed down and the overhead reservoir at Tallah came into existence.

In course of his experiments Clemesha laid down the technique of water examination and a workable standard for the tropics for judging the potability of water. This was the standard which the Corporation Laboratories both at Calcutta and Pulta closely followed till a new standard was laid down in 1937 by the London Ministry of Health.

The Corporation Laboratory has also worked out the standards of purity of foodstuffs, like milk, dahi, chhana, khoa, ghee, butter, mustard oil, cocoanut (edible) oil, wheat flour (*maida*), *ata* and tea.

Manufacture of Fish Oils in India

At the fourth meeting of the Medical Stores Supply Committee held in New Delhi yesterday, the chairman Lt. General G. G. Jolly, director-general, Indian Medical Service, revealed that a flourishing fish liver oil industry existed in the Madras Presidency 80 years ago. Apparently this flourishing concern was gradually killed by competition in prices.

Medicinal liver oil from the shark and saw-fish is once more being produced in Calicut. It is understood that efforts are also being made by the Governments of Bombay and Bengal and the State of Travancore to manufacture fish oils. Modern research has shown that the use of shark and saw-fish liver oils as a substitute for cod liver oil is sound practice, since the former are considerably richer in vitamin A than cod liver oil. Yet long before vitamins were heard of, the medicinal value of shark and saw-fish liver oil was recognised in India where vitamin A deficiency is widespread.

A modern industry engaged in the production of medicinal fish liver oil enjoys the advantage that scientific methods for testing and standardising such oil are available. Investigations about the vitamin content of oil in the Nutrition Research Laboratories, Coonoor and other laboratories have played an important part in recent developments. There is an enormous need in India for cheap medicinal products rich in vitamin A and other vitamins.

The *Report on the Sea Fish and Fisheries of India and Burma* by Surgeon Major Francis Day, inspector-general of fisheries, published in 1873, shows that in the sixties of last century there was a considerable production of fish oil on the West Coast. For the years 1864-71, the high figure of 3,194,672 lbs. with a value of Rs. 2,03,829 is given as the export from Madras alone. This was not medicinal oil, but chiefly sardine oil used for a variety of purposes. But medicinal oil, obtained from the shark and saw-fish, was being produced simultaneously, apparently mainly for use in India.

itself. For some years over 5,000 lbs. per annum were manufactured, the price ranging from nine annas to Rs. 1/4/- per lb. The main centre of production was Calicut, where manufacture was initiated in 1854, the process being under the supervision of the civil surgeon of Malabar.

It is not clear from the report whether medicinal oil was also manufactured in Bombay and Sind. About 1870 the cost of cod liver oil fell below that of Indian fish liver oils and apparently the Indian industry languished because it could not compete with the imported product.

Blood Groups for Everybody : The Four Groups

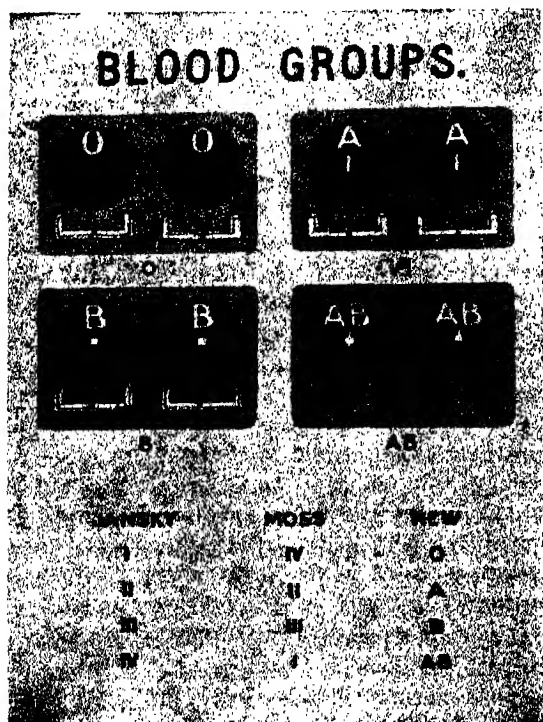
MRS S. D. S. GREVAL

WHAT THEY ARE

IMAGINE to yourself small discs, say rupees, being moved round and round in a limited space, say, a tumbler. Also imagine that there are four sorts of discs: (i) those that are entire, (ii) those that have a slit in them, (iii) those that have a square aperture

the discs with the combination of the slit and the square AB.

Further, imagine fasteners with narrow compressed and upright ends and with thick square and upright ends. These fasteners are also shown in the diagram. Let us call the first fasteners with the narrow ends a and the second fasteners with the square ends b. It will be seen that discs O (entire) have associated with them both the fasteners a and b; the latter cannot fasten the discs because of their inability to fit into them. The discs A have associated with them the fasteners b; the latter, again, cannot fasten the discs because of their inability to fit into them. The discs B have associated with them fasteners a; the latter, once again, cannot fasten the discs because of their inability to fit into them. The discs AB have associated with them no fasteners at all; that is the only way they can be kept free, because either type of the two fasteners is capable of fastening them.



Illustrating the group-classification of human blood.

in them and (iv) those that have a combination of a slit and a square in them. These features of the discs are illustrated in the accompanying diagram. Let us call the discs that are entire O, the discs with a slit A, the discs with the square aperture B and

If you were to add to the tumbler in which the discs and the fasteners are lying, some water, the picture would be complete. The tumbler would be a blood vessel and the discs red blood corpuscles which by virtue of a substance contained in them or absent from them are divisible into four groups: group O (substance absent), group A (substance A present), group B (substance B present) and group AB (both substances present). The substances are stickable and the red blood cells containing them are stuck together (fastened) agglutinated by the appropriate sticking substances. The fasteners, which are purely imaginary as far as their shape goes would be the appropriate sticking substances in the added water. The stickable substance A is technically called isohaemagglutinin A and the stickable substance B is isohaemagglutinin B. The sticking substance (the fastener) a is the isohaemagglutinin a and the sticking substance (the fastener) b is the isohaemagglutinin b.

Technically the blood groups are constituted thus:—

Isohaemagglutinin		Isohaemagglutinin		
O	and	ab	=	group O
A	"	b	=	" A
B	"	a	=	" B
AB	"	o (nil)	=	" AB

The blood groups have been named in three different ways. The diagram gives the equivalents of the new way in old terminology also. The new way has come to stay.

THEIR USE IN BLOOD TRANSFUSION

In blood transfusion blood is taken from the veins of a healthy person, the donor, and injected into the veins of a sick person, the recipient. Before doing so it is ascertained whether the injected blood will be without effect on and will not be affected by the blood in the recipient, in other words the compatibility of the two bloods is ascertained. The donor and the recipient must either belong to the same group or the donor must be a *safe universal* donor. All group O donors are usually called universal donors, though all of them are not safe. For details on compatibility recent writings on the subject must be consulted.

THEIR USE IN DETERMINING PATERNITY AND MATERNITY IN CASES OF DOUBT OR DISPUTE

Doubts and disputes on the paternity and maternity arise from various causes. Without going into the details of Mendelian inheritance and other biological subtleties it may be stated simply that the blood group of the father and the mother can be inherited by the offspring in a certain way only. The following table gives the inheritance of the blood groups. It will be seen that the determination of the blood group for the purpose (the blood test) can only say that Master Tom cannot be the son of Mr Smith. It cannot say that Master Tom is the son of Mr Brown. The most it can say is that Master Tom can be the son of Mr Brown. The same remarks apply to the maternity of Mrs Smith and Mrs Brown.

When blood groups fail, blood sub-groups and blood types may succeed. They deserve an independent communication.

TABLE SHOWING THE INHERITANCE OF BLOOD GROUPS.

BLOOD GROUPS IN PARENTS AND CHILDREN.

	Parents	Children possible	Children impossible
1	O × O	O	A, B, AB
2	O × A	O, A	B, AB
3	O × B	O, B	A, AB
4	A × A	O, A	B, AB
5	A × B	O, A, B, AB	...
6	B × B	O, B	A, AB
7	O × AB	A, B	O, AB
8	A × AB	A, B, AB	O
9	B × AB	A, B, AB	O
10	AB × AB	A, B, AB	O

THEIR USE IN THE STUDY OF GENETICS

A very simple instance of the inheritance of the dominant and recessive characters is the inheritance of the blood groups. Mass statistics have fully confirmed the hypothesis. Those interested will read the recent literature on the subject. Room for subtleties in explaining unexpected findings also exists. It is worthy of remark, however, that the number of unexpected findings has steadily decreased with the improvements in the technique of grouping blood.

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Organization of Public Health and Medical Services in India*

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LANDMARKS IN PUBLIC HEALTH ADMINISTRATION IN INDIA

In a review of the public health administration in India at least three landmarks in the history of its development have to be considered†:—

- I. The appointment of a Royal Commission to enquire into the health of the army in India in 1859.
- II. The report of the Plague Commission in 1904 following the outbreak of plague in 1896.
- III. The Reforms introduced by the Government of India Act of 1919.

The Royal Commission of 1859 was appointed to enquire into the extremely unsatisfactory conditions of the health of the army in the country. Between 1859 and 1863, the mortality rate among European troops was 69 per 1,000, while among European women in 'married quarters' it varied from 44 to 276 per 1,000. The Royal Commission recommended measures not only for the army but also for the civilian population. In accordance with its suggestions 'Commissions of Public Health' were established in Madras, Bombay and Bengal in 1864. The Commissions in Madras and Bengal, though they advocated far-reaching measures including the employment of trained public health staffs in the districts, did not lay down any definite policy. In the words of a former sanitary commissioner with the Government of India, 'Government had to deal with a population which was unwilling and unready to receive sanitation, which either frankly disbelieved in its efficacy and resented any change in established customs or was too ignorant and apathetic to understand the goal at which it aimed. Sanitary measures were received not only by indifference but by active opposition.' Under the circumstances, very little advance was possible, but the outbreak of plague in 1896 raised issues of fundamental importance which

can best be summed up in the words of the sanitary commissioner at that time:—

'When plague appeared it was not a new disease, but it was new to the present generation in Indians and it has exacted a very heavy toll of deaths all over the country. The strangeness of the disease, the unpopularity of the measures taken to control it and the importance of these measures have served to rouse the people from their apathy and concentrate the attention of all, but especially of the educated classes, on sanitation in a way that nothing else could have done.

'At the same time plague has not been without its effect on Government. Previous to the advent of this disease it had been the generally accepted opinion that sanitation was the work of any medical officer and required no special training. A special sanitary staff had, therefore, not been considered of any very great importance. When plague appeared the staff was inadequate and unprepared; action was taken on general principles and sanitary measures were adopted, which, with further study of the aetiology, we now know were unsuitable and could do little to check the spread of the disease. The waste of life, time, money and effort that resulted has impressed on Government the necessity of being prepared in future and large changes have been effected with that object.'

The report of the Plague Commission in 1904 advocated the reconstruction of the Sanitary Department on a wide imperial basis, with the provision of adequate laboratory accommodation for research, teaching and the production of sera and vaccines. The Indian Research Fund Association was formed in 1911 and a forward sanitary policy, with a devolution of powers to the local governments, was formulated in a resolution of the Government of India in 1914.

The Montague-Chelmsford Reforms of 1919 had a very marked effect on public health administration; this was partly beneficial and in other respects detrimental. Provincial ministers responsible to the legislature were anxious to hasten the growth of

* Adapted from Sir Raim Nath Chopra's presidential address delivered at the annual meeting of National Institute of Sciences of India at Benares on January 2, 1941.

† Raja, K. C. K. B. 'A plea for a forward Public Health Policy in India.' *Ind. Med. Gaz.*, July, 1937.

education, medical relief and sanitation so far as funds permitted. The organization of trained public health staffs for urban and rural areas, which the commissions of public health had recommended in the sixties of the last century, was at last taken up in earnest and in the years succeeding the introduction of the Reforms, the organization of health services became a marked feature in most provinces. Since 1921 there has indeed been far greater public health activity in the provinces than ever before.

All civil medical services in presidencies and provinces were formerly under the control of a single administrative officer known as the Surgeon-General in the former and the Inspector-General of Civil Hospitals in the latter. Unfortunately, owing to an insistent demand for medical relief, which is what appeals most to the individual in a community with a relatively low standard of living, the available funds were expended in the main on increasing and improving hospitals and dispensaries, and the obvious need for more and yet more of these, associated with a chronic shortage of funds led to the neglect of preventive measures and particularly of those fundamental but costly ones comprised in the term 'Environmental Hygiene'. Relief of sickness and suffering was readily understood and appreciated by the public, while the application of sanitary measures, implying as it did interference in age-long habits, with restrictions which were regarded as irksome and trespassing upon vested interests or religious customs, was opposed on all hands by the people who are as conservative as any in the world. *En passant* it may be noted that the position in India at this time was generally very similar to that in England some hundred years ago.

SEPARATION OF PREVENTIVE AND CURATIVE DEPARTMENTS

Early in the present century the Secretary of State for India caused the separation of preventive from curative medicine by creating in each presidency and province a separate 'department' for preventive medicine, with an independent budget, and under an officer designated as the 'Sanitary Commissioner'. The name of the officer was changed in 1922 to the less appropriate one of 'Director of Public Health', and his department was also designated as the 'Public Health Department'. In many provinces the division of duties as between the heads of the departments of curative and preventive medicine was not fully specified, and only a broad distinction of curative and preventive medicine was regarded as sufficient. The formation of separate departments for preventive medicine in the various provinces provided a great impetus for this branch of medical

work, and far-reaching, much-needed reforms were planned. They found themselves faced with the immense problem of environmental hygiene in a land where, even in towns, safe water supply and sanitary systems of sewage and rubbish disposal were, as a rule, conspicuous by their absence, the housing of the poorer classes was atrocious, and local administration, except in a few outstanding cases, was overshadowed by vested interests and correspondingly inefficient. In the rural areas sanitation simply did not exist, soil pollution was general, flies swarmed, malaria and hookworm infection were almost universal, leprosy and tuberculosis were wide-spread, and small-pox, cholera, and plague regularly took their periodic tolls uncontrolled by any environmental checks or preventive measures. The provision of properly qualified and trained staff for this work presented a serious difficulty. The medical department had its system of hospitals and dispensaries manned by civil surgeons, assistant surgeons, and sub-assistant surgeons. In some provinces the civil surgeons, originally ex-officio district medical and sanitary officers, retained the dual charge, while the public health department was building up a subordinate personnel of sanitary inspectors, epidemic sub-assistant surgeons or health assistants to civil surgeons and later health visitors. All these worked under the director of public health who had one or more assistant directors and other specialists, leaving the provision of the more costly full-time district health officers until the subordinate personnel had been trained and appointed. Other provinces hastily appointed expensive district sanitary officers, whom in some cases they called medical officers of health, although, owing to the fact that every district already had a district medical officer or the 'civil-surgeon' as he is usually called throughout India, their duties were not comparable with those of medical officers of health in England. Further, in the absence of a separate staff of subordinates the work of these new officers was limited to advising only. As an exception, however, the presidency of Madras succeeded in creating a complete staff of health officers, assistant officers and sanitary inspectors.

LACK OF CO-OPERATION BETWEEN MEDICAL AND PUBLIC HEALTH DEPARTMENTS

The question at the present time is the lack of co-operation and consequently of co-ordination obtaining in many parts of India between the official medical and public health departments.* This is a problem peculiar to India, for it does not exist in Western countries nor in the Dominions and Colonies

* Jolly, G. G. 'The need for co-operation in the Medical Health Services of India, with special reference to Maternity and Child Welfare.' *Ind. Med. Gaz.*, April, 1940.

where the separation of the official health services into 'curative' and 'preventive' sections has never been effected. To some extent this is due to the unsuitable titles given to the respective departments and still more to their administrative heads. There is sufficient evidence of a lack of co-operation between the two official departments and of the development of 'exclusion' instead of an *esprit de corps*, which can only be destructive in its effects. The situation requires to be met by a close liaison between the two branches, such as, for example, obtains in the Government of India, where the Director-General, Indian Medical Service, has the Public Health Commissioner working with him in his office as his principal staff colleague. Such an arrangement not only conduces to a close co-operation, but the distribution of work is facilitated. The urgent necessity for a friendly collaboration between the two departments, if the system is not to break down, is essential, and is recognized by experienced administrative officers of both departments. The Central Advisory Board of Health, established in 1937, should prove a valuable agency in this direction. At its meeting in Madras in January, 1939, it passed the following resolution for the establishment of similar Provincial Boards of Health:

'The Board stresses the desirability of establishing in each Province and State an Advisory Board of Health with the Minister-in-charge as Chairman'.

While in reference to Maternity and Child Welfare it adopted the following resolution:

'Co-ordination between the medical and public health departments is perhaps more vital in the field of Maternity and Child Welfare than in any other of medical and public health work.'

If a policy of close friendly collaboration obtains between the two departments in the provinces and the relative spheres of each are defined, the existing system will continue to function tolerably well, but if friendly co-operation that should be sought and loyally observed by the workers in both the departments is replaced by a spirit of exclusion, and co-operation is stigmatized as a 'dual control', then a position in which the two departments are in opposition will arise sooner or later and the profession will be divided into two camps. Such a state of affairs will hardly be in the interest of either of the two departments, while the effects of such a controversy are bound to lead to a great deal of suffering for the poor public.

The best solution of the problem appears to be the establishment of ministries of health in various provinces modelled on the English system with suitable modifications in regard to the local conditions.

PUBLIC HEALTH SERVICE IN GREAT BRITAIN

The modern public health service in England is barely a quarter of a century old, and like so many of the English institutions it arose more by accident than by design. The dissolution of the monasteries left the destitute without any visible means of support until the year 1601, when the Elizabethan Poor Law established Parish Overseers and Workhouses—this system remained practically unchanged for over two centuries. Besides relieving destitution, these authorities carried out any measures that were necessary for the public health, such as the control of epidemics, the provision of sewers, or the abatement of sanitary nuisances. In 1834 the Poor Law Amendment Act was passed after a great deal of agitation and following the Report of the Poor Law Commission of 1832. This important Bill amalgamated the separate Parishes into Unions under the control of Boards of Guardians. District medical officers were appointed to attend to the sick-poor, while the infirmaries were built to accommodate paupers who were too ill to be kept in the Workhouses. In 1835 the Municipal Corporations Act was placed on statute book to reform the chaotic state of the Borough Government.

Despite all these changes, the state of the public health was never taken very seriously until the cholera epidemics between 1839 and 1854 galvanized the Government into action. Edwin Chadwick, one of the Poor Law Commissioners, in his *Survey into the Sanitary Condition of the Labouring Classes of Great Britain*, exposed not only the insanitary evils of the towns and villages, the hideous legacy of the Industrial Revolution, but, by showing how closely disease was related to poverty, provided a convincing argument in favour of far-reaching reforms. His 'sanitary idea' led to the appointment in 1848 of the General Board of Health, which, after a stormy life, was superseded by the Local Government Board of 1871. In 1872 the country was divided into urban and sanitary districts, and medical officers of health and inspectors of nuisances were appointed for the first time. Credit is due to the authorities of the Liverpool Borough for having had the vision to appoint a Medical Officer of Health much earlier. Then followed the great Public Health Act of 1875 which is the bulwark of all sanitary laws.

A further Municipal Corporation Act was passed in 1882, while the year 1888 was conspicuous for the creation of County Councils and County Borough Councils. From this time onwards there has been an ever widening stream of health legislation. Statute after statute has swollen the ranks of the public health service to such an extent that today

there is scarcely any field of human activity in which the health officer does not play an important part. Another important landmark, the National Health Insurance Act of 1911, provided the adult manual worker with compulsory insurance against loss of health. The Bill was hotly contested during its passage through Parliament, but it was successfully piloted and passed into law through the efforts of Mr Lloyd George.

Finally, the creation of a Ministry of Health in 1919 in place of the Local Government Board was the crowning recognition of the importance of health in the nation's life. This wise step was made inevitable by the Great War of 1914-18.

The general powers and duties of the Minister in relation to health are defined in the second clause of the Ministry of Health Act, 1919, as follows: To take all such steps as may be desirable to secure the preparation, effective carrying out and co-ordination of measures conducive to the health of the people, including measures for the prevention and cure of diseases, the avoidance of fraud in connection with alleged remedies therefor, the treatment of physical and mental defects, the treatment and care of the blind, the initiation and direction of research, the collection, preparation, publication and dissemination of information and statistics relating thereto, and the training of persons for health services.

PROPOSED FEDERAL MINISTRY OF HEALTH OF THE GOVERNMENT OF INDIA

In India a Federal Ministry of Health should be established at the centre to provide the necessary co-operation agency for the provincial local self-government departments, which are at present responsible for the supervision of local bodies and for public health administration in the provinces. This Ministry would also be responsible for the other health functions statutorily conferred on the Central Government by the Government of India Act of 1935. All problems in connection with curative and preventive medicine should be dealt with by one department divided into appropriate sections. The following sections are tentatively suggested for consideration :—

1. Prison medical service.
2. Port sanitation and quarantine service.
3. School medical service.
4. Public health, including—
 - (a) Medical intelligence, infectious diseases and international health.
 - (b) Nutrition, food and drugs administration including biological products.

(c) Environmental hygiene including housing, water supply, drainage, waste products.

(d) Industrial hygiene.

5. Medical relief, including—

(a) Maternity and Child Welfare, venereal diseases, tuberculosis, leprosy.

(b) General practitioner services with special reference to rural dispensaries.

(c) Hospitals.

(d) Drug addiction.

(e) Health Insurance.

6. Lunacy.

7. Scientific research.

For these purposes, the Ministry should have a highly trained staff of expert advisers. The Director-General, Indian Medical Service, who as the Surgeon-General with the Government of India most nearly corresponds to the Chief Medical Officer of the Ministry of Health in England, has at present an insignificant number of specialists on his staff. In England though public health administration is established on well-regulated lines, the Chief Medical Officer controls a strong team of workers in each special subject of medical health work, such as maternity and child welfare, tuberculosis, industrial hygiene and so on. In India, on the other hand, while the conditions are much more complex, and although the necessity for an expansion of the Central Government's technical staff has been repeatedly stressed by the Directors-General and Public Health Commissioners, the task is left to only two or three officers.

The materials for the establishment of a Ministry of Health at the centre in India are all available. Thus, though many of the bureaux are under private bodies, their directors act as advisers to the Director-General, Indian Medical Service, who, as a rule, is connected with such bodies as the chairman of their managing committees. Thus with the Director-General at the top we have roughly :—

1. Public Health Commissioner.
 - Bureau of Quarantine, Infectious Diseases and International Health.
2. Deputy Director-General.
 - Personnel and Establishment, Medical Relief, Medical Education, etc.
3. Assistant Director-General (Stores).
 - Medical Supplies.

4. Maternity and Child Welfare Bureau of the Indian Red Cross Society.

The Director-General is the Chairman of the Bureau.

5. Medical Commissioner of the Tuberculosis Association of India.

The Director-General is the Chairman of this Association.

6. Medical Research.

The Director-General is head of the Medical Research Department and Chairman of the Scientific Advisory Board, Indian Research Fund Association, while the Public Health Commissioner acts as its Secretary.

7. Drugs Control.

The Director-General has the Director of Drug Control Laboratories on his staff, and he is also the Chairman of the Advisory Board for Drug Control.

8. Nutrition.

The Director of Nutrition Research Institute as the officer-in-charge of the Nutrition Enquiries of the Indian Research Fund Association, acts as the expert adviser to the Director-General.

9. Malaria.

The Director of the Malaria Institute of India acts as the adviser to the Director-General.

Other loose connections exist or are being forged, e.g., leprosy through B. E. L. R. A.: food standards through a standing committee to be set up by the Advisory Board of Health, while new connections have to be established with the railway medical services, prison medical services, school medical services, etc.

The provision of a suitable staff of experts must devolve on the federal government and cannot be relegated to the provinces. The Royal Commission on Health in Australia (1925) emphasized that, as 'the success of health administration is more dependent on the personality and capability of the officers directing it than on any other single factor, the Commonwealth Government should be responsible for the maintenance of highly trained experts to advise and help local authorities when desired by State Health Administrations'. If such an arrangement has succeeded in Australia, I agree with Raja (1937) that a similar plan might be equally successful in India. Moreover, a carefully selected central staff

would, to some extent, avoid the duplication of posts of highly specialized men in the component States of the federation, while the position and prestige of the federal administration should enable it to attract the proper type of men.

The selection of the federal chief medical officer should, however, be dependent on his having both medical and public health experience, and his deputies must be given a chance to familiarize themselves with the wide range of the curative, preventive and constructive aspects of medicine in the country.

PUBLIC HEALTH ORGANIZATION IN THE PROVINCES

Each province should have a chief medical officer responsible to the Minister of Health of the province for the administration of the whole of the medical subject with a number of deputies in charge of the various departments, e.g., prisons, schools, medical and public health problems. The deputies should be given a chance to work in different departments so that the chief medical officer of the future would have men available with firsthand experience of individual and environmental hygiene, while regional medical officers should be appointed to look after various areas or zones.

A provincial board of health under the chairmanship of the Minister of Health should be constituted in each province. The members should be drawn from the medical and public health specialists and suitable persons should be co-opted for different problems. The help of the revenue, education and public works departments would be needed to shape the health policy of the provinces. Suitable persons may be constituted into *ad hoc* committees to tackle important problems of general and local interest, while the co-operation and advice of the specialists on the staff of the Federal Ministry of Health should be available to the provincial governments in connection with problems of an all-India nature.

In the districts, districts health committees should be formed for the same purpose. These should be presided over by the collector of the district or the president of the district board; the co-operation of both agencies is essential, and this alone will make it possible for these committees to work efficiently.

So far as the rural population is concerned, medical men engaged in curative work should be able to undertake public health duties as well. Their education and training should be of such a nature as to enable them to do so without difficulty. The doctors engaged in combating epidemic diseases

should be expected to undertake public health work when not dealing with outbreaks of infectious diseases. The rural doctor, who is the final link between the health services in this country and the people, should also be responsible for giving an elementary health education to the patients in connection with their immediate surroundings. Such instruction would be much more effective than general lectures and demonstrations to large audiences.

CONCLUSION

The State is essentially responsible for providing the necessary agencies for both preventive and curative medicine. Curative medicine forms an integral part of the public health services of a country inasmuch as very often the sick man is the source of infection and no constructive medicine is possible unless the population is rendered free from disease by treating the individuals. Again, according to the newer conceptions of a State, it is necessary that disablement whether temporary or permanent should through intensive use of curative medicine be cut down to the barest minimum. Moreover, it is through curative medicine alone that it is possible to win the confidence of the public in a country like India and bring home to the people the advantages accruing both from preventive and constructive medicine.

Starting from the bottom, I consider that to meet the requirements of public health of the population there should be a combined establishment which should form the basis of preventive, curative, and constructive medicine in each village. This should be linked up with a more organized central agency discharging these combined duties and catering for

a convenient-sized population, the bulk of which will depend upon various factors such as communications, incidence of disease, etc. These primary organized centres will have to be supervised and assisted by a district centre in which there should be a specialized staff for the main medical subjects. These district centres in turn should be in touch with a larger provincial organization in which the staff consisting of specialists in various branches of medical science should work under a senior and experienced medical man. This latter should constitute the administrative head of the medical service in the province under the provincial Ministry of Public Health. He should have a thorough training in the methods of public health administration, community health organization, constructive medicine, etc. The staff of the provincial organization should further be large enough to be utilized for medical and public health training both for under-graduate and post-graduate work.

The activities of the health organization in different provinces should be co-ordinated by a more elaborate and efficient federal or an all-India organization working under the Federal Ministry of Health. The administrative head should be an officer with wide experience of preventive, curative and constructive medicine, and have on his staff expert advisers in as many of the important branches of medicine as possible. With the advice and help of these advisers, it should be his duty to deal with and co-ordinate the problems of public health which concern the country as a whole. Curative and preventive medicine must work as one single whole ; to let them work separately in water-tight compartments is sure to lead to confusion, while only an organization of the nature detailed above will be able to deal successfully with the multifarious problems of public health in this vast country.

FUMIGATED MAIZE TO FOWLS TAINTED EGGS

Maize samples were kept in cardboard boxes with a quantity of paradichlorobenzene as museum exhibits. After some months they were discarded and lay exposed to the air for at least four weeks. These grains were shelled and fed to a number of fowls ; the maize being mixed in the proportion of approximately one-third maize and two-thirds unfumigated wheat. The mixture was used for the evening meal only. The *Agricultural Gazette* of the New South Wales reports that within a short time of commencement of feeding a slight egg taint was noticed. The tainting steadily increased until at the end of twenty-one days after commencement of feeding the taint was so objectionable that the eggs became uneatable. Moreover, the taint was carried through in various cooked sweets and cakes to such an extent that comments were passed by strangers who had no knowledge of the egg taint.

For some days after cessation of the feeding with the fumigated grain the eggs remained uneatable, but the taint gradually became fainter and the last noticeable taint was detected in an egg which was laid fortythree days after the removal of the maize from the mixture. However, the eggs were eatable long before this period.

BOOK REVIEW

The Economic History of Steel-Making, 1867-1939

—by D. L. BURN. Published by Cambridge University Press, 1940. Pp. xi+548 with 4 graphs and 2 maps. Price 27sh. 6d.

The book, as the title makes clear, deals with all the aspects of the economic history of steel-making. Iron has been and will undoubtedly continue to be of the greatest use to man, especially in the form of steel. In fact the backbone of our present day civilisation is made of steel. Its study has always been a fascinating one and shall ever remain so.

The study of economic history of steel-making is of all the more importance to India at this juncture as she is on the verge of industrialisation and is seriously busy in planning its national life. It need hardly be said that industrialisation cannot be even thought of unless the country is able to produce cheaply and efficiently a large amount of steel. The experience of the various steel producing countries, the difficulties they have been encountering and the organisations which have been set up from time to time for the above purpose will make valuable reading to every thoughtful person.

The book, under review, deals with all these points in a very comprehensive manner. It shows, among other things, how an important country like United Kingdom, with its huge empire and enormous resources, received a shake-up in some aspects of steel trade even in its own market. This has been stated to be due to indifferent technical workers, bad location of different plants, obsolete machinery, inefficient working, waste of fuel and too much individualistic nature of the industry. The book further shows that protection of any industry without proper State control is not of much assistance to it.

Attempts were made to grapple with the problems of the steel industry in the United Kingdom by the Government during the last Great War and after it. Several bodies were set up to regulate the industry. During the thirties of the present century several Government committees (e.g., Sankey and May Committees) enquired into the working of the industry and many important measures were re-

commended. Sankey Committee found that 'wise planning of steel-making, from a national standpoint, cannot be perfectly achieved by the steel industry acting in isolation. If the disasters of the past are to be avoided, without a merely negative policy, then the actions of several industries must be concerted'. Unfortunately, for various reasons, elaborated in the book, all the recommendations of these committees were not acted upon and the steel industry in the United Kingdom did not improve as much as it could have done. As Mr Burn says 'it would not be surprising if in the near future the growth of competition—from foreign producers in export markets, and from possible substitutes in the home trades—together with the threat of war provide a greater stimulant than any promptings of the committees.

The book is well documented with a wealth of references. The author has been at pains to substantiate every little remark of his by quoting at length various authorities and giving elaborate statistics. The general get-up of the book is excellent as is usual with all Cambridge University publications. The author is to be congratulated for his book, which would certainly find a place in all libraries.

H. T.

Physical Science in Art and Industry—by E. G. RICHARDSON, B.A., Ph.D., D.Sc. Published by English Universities Press Ltd., London, 1940. Pp. xi+293 with index and 73 illustrations including lines, plates and curves. Price 15sh. net.

The book is a semi-technical exposition on the application of physics in its various branches and is presented in an interesting manner which would stimulate scientific ideas in the readers. The author writes in his preface "... it may be found more serious reading than the first book", with reference to his earlier publication, *Physical Science in Modern Life*. "I hope" the author continues in the preface, "it will appeal to those professional physicists—

whether research workers or teachers—to whom the earlier one would appear puerile". This makes the author's motive clear. The book will be very helpful as each chapter is provided with a short bibliography on the topic of the chapter.

The book opens with locomotions of vehicles, ships and aeroplanes and three chapters are devoted to the subject. It does not merely describe the construction of the machines (which may be the province of a 'popular' book) but points out the various problems and their solutions which have led to the improvements in the technique of modern traffic and transport. These chapters deal with in a non-mathematical way the science of road-making, discovery and advantage of pneumatic tyres, speed of racing car, stream-line body, rocket car, problem of friction, coupled wheels, sails (flat and rotating drum), propulsion screw, consideration of lift and drag in an aeroplane, wind tunnel, and problems of aerofoil.

In chapter IV the author deals with communication physics of telegraphy and telephony, not excluding principles of hearing, ear-impedance and subjective tone.

Chapters V and VI are devoted to pottery and culinary art both of which have great deal to do with grain size (of clay or flour as the case may be), adhesives between the particles, elasticity, plasticity, problems of baking etc. The next chapter, Physics on the Farm, deals with soil fertility, colloidal soil, soil texture, capillarity of soil, etc. All these chapters take into account in an interesting way the principle of Stoke's sedimentation law, measurements of turbidity and particle size by photoelectric method. The discussion on artificial heating of soil in the northern countries with manure, steam pipe and electrical means, is interesting.

The next chapter on River Hydrology gives the reader an idea of the science of erosion and silt deposition as the stream flows on. It also describes the laboratory experiments with model rivers for the study of the same. Soil texture and porosity and other factors dealt with in earlier chapters have great bearing on the river physics, so that the author's arrangement of the chapters has been a linked one.

The chapter on Mine Physics discusses the sources of mine accidents and its remedy through the application of photoelectric relay, noxious gas detectors, safety lamps, dust precipitators and a number of other devices. The other side which deals with echo-prospecting for subterranean oil strata, magnetic-prospecting for iron and other magnetic ores, and electrical prospecting for coal, is highly interesting.

Such prospecting has again been referred to in the next chapter on Fine Art and Archaeology. Apart from aerial survey of the archaeological sites the seismic or echo-prospecting in conjunction with a cathode-ray oscillograph gives a check against indiscriminate digging. On the other side, paints and paintings have been discussed in the light of physical science. The grain size of the paints, dispersion medium, thixotropic behaviour of the paint emulsion have been discussed in an interesting way. The employment of electron microscope for the determination of the uniformity of paint grains, and of tintometers for grading the colours, rouses considerable interest. It has also been pointed out how the examination of the old masterpieces of painting and old documents under infra-red, ultra-violet and X-rays have enabled the scientists to disclose a number of mysteries relating to many of them.

Chapters XI and XII on Building Materials and Architectural Physics deals with strength of materials, acoustical and thermal insulating properties, sound- and light-condition in the room and auditorium, and other allied problems like ventilating and air-conditioning of rooms and vehicles. The acoustical conditioning, and the consideration of reverberation in a lecture theatre or in a music hall is interesting. The day-light effect and glare-proof diffuse illumination has been referred to; the problem of polarized light and its glareless illuminating property has however been omitted. Polarised light has not only been employed with success in microscopy, but the use of polaroids is coming to a commercial possibility in producing glare-proof illumination indoors.

In the next chapter (XIII) on Science and the Musician some of the problems on the construction of different musical instruments have been taken up. It also refers to straight and bell-shaped end of wind instruments in connection with exponential curve of a loud speaker or other tone-chambers for low acoustical impedance and proper sound radiation. Sound boards of stringed instruments have likewise been noted. The chapter has also presented the principles of electric organs working with oscillating circuits, and the interesting methods of blending the concordant harmonics. The blending of harmonics however cannot produce a true copy of the tune of a clarinet or a violin which, apart from their harmonic admixture, has characteristics arising from the wood and metal structures and air cavities, which give rise to defective minor notes. The author has also discussed the psychological effect produced by a natural instrument against an electric one in which the faults of a natural instrument are absent. He

however asks the readers and the musicians to decide which of the natural instrument and the ideal electronic should be preferred and followed. The same problem arises in connection with the faithful reproduction in high-fidelity microphone. The author might have hazarded a decision on this matter supported by the modern studio practice which filters out some undesirable harmonics and alters the proportion of bass to sharp overtones in a vocal or natural instrumental music.

Coming next to textile physics we read the behaviour (strength, flexibility, etc.) of silk, wool and cotton fibres under different conditions of moisture, heat and physico-chemical treatment. It also touches upon the manufacture of rayons, and the effect of mercerisation on cotton fibres. The chained structure of molecules in a fibre as indicated by the X-ray study under normal as well as tensioned conditions has also been explained. The study and grading of colour and lustre of the fabrics have been appropriately included.

The last chapter (XV) is on the art of war which is of considerable interest at the time of publication of the book. Most of the war tactics, as the author has mentioned at the beginning of the chapter, are secret, but some knowledge has percolated out. The chapter is devoted to sound ranging, determination of the velocity of explosion wave in powder, velocity of bullet and its range etc. This chapter appears to have fallen short of a reader's expectation. The chapter is short compared with the average length of the others. We do not find any reference to optical and ultrasonic ranging for sub-marine detections. The reader will be particularly disappointed not to find any mention of magnetic mine which is so much heard of at the present time. Probably the author has been very cautious not to probe into secret researches.

To sum up, we repeat that the book has been an expert presentation of the principles of physical science which is the source of vast developments in various branches of art and industry of today. The author deserves congratulations for bringing out such a book with a vast wealth of information at this time.

K. Ray.

**Forest Research in India, 1938-39, Part II—
Reports for Burma and Indian Provinces—
Government of India Publication.**

Forest research* in India falls under the following four major divisions, namely (i) silviculture and working plans, (ii) forest botany, (iii) forest ento-

mology and (iv) utilisation and economic research. The work under each head is again classified according to provincial requirements.

Experimental silvicultural operations in the several provinces include natural and artificial regenerations, seed test and nursery works, reclamation and afforestation, tending and preservation and other miscellaneous items of work. Natural regeneration of forest species appears to vary from province to province in method and in the species treated, the procedure adopted being adaptable to the peculiar needs of the particular species tried and to the natural conditions and prevalent types in the areas worked.

The special types of forests that have been tackled so far are (1) the ever-green forests of *Dipterocarpus turbinatus*, *Phoebe goalparensis* etc., in Assam, (2) Sal (*Shorea robusta*) in Bengal and Behar, where such other forests as those *Acacia catechu* and *Dalbergia sissoo* in the savannahs of Bengal and of *Dendrocalamus strictus* in Behar are also under study, (3) Teak in Madras, Coorg and Burma, besides such evergreen types as Hopeas, *Calophyllum* and *Dysoxylum* in Madras, (4) Conifers in the Punjab and the N. W. F. Province etc.

The results of these silvicultural experiments, which are subject to diverse natural and biological factors appear to have been variable, being good, bad and indifferent. As exploitation of the Indian forests without sufficient stocks would end in a disaster of great magnitude, the work of regeneration, reclamation and afforestation assumes very great importance and should probably be carried on unceasingly, with enthusiasm, forethought and intelligence, gained by ups and downs met with in the course of the work.

Apart from work on indigenous species, the forest research appears to have been directed to exotics as well, such as the tung oil plants in Coorg, Madras and Bombay, the African oil palm, the Andaman padauk and camphor plants in Madras. The hopeful results obtained so far is encouraging and augurs well for the welfare of the country.

On the entomological side, the defoliators of teak, *Dipterocarpus* etc., and the beehole borers of several other trees were referred to the forest entomologist, Dehra Dun. The problem of sandal spike and its control has been engaging the attention of the research section of Madras forest department for a considerable time and yet its control appears to be an unsolved one.

Lastly, but the most important of all, because of the revenue yielded by them, is the research in utilisation and economy. The several items that

* A review of the Part I of the Report was published in the September issue (pp. 163-5) of this journal.

come under this head are wood technology, wood seasoning, timber testing, wood preservation, wood working, match woods, firewood and charcoal, wood for packing cases, plywood and veneer paper pulp, tans, minor forest products, initiation of cottage industries, commercial activities, publicity, propaganda, help and advice. A perusal of the work under each of the above items of work reveals the fact that there are vast quantities of raw materials in the forests of India sufficient to support a number of industrial enterprises such as manufacture of paper, plywood, tool handles, matches, tea boxes, etc., etc.

The idea of preservation of natural flora and the maintenance of different types of forests has not come a day too soon and the forest department in Bengal which reports of attempts at such a venture has to be congratulated. Because it is very well known to one and all that there are, if any at all, only a few inaccessible spots in the forests of India that has resisted the woodman's axe and rapacity in the past. Natural forests have not only an economic value but also a very high educative value in the study of the science of botany and allied subjects. Legislation against wilful devastation of forests and extinction of rare species has come to the aid of the botanist in other parts of the world. But India has not been fortunate in that respect. A sense of preservation and maintenance of natural flora is a welcome sign for the future of our natural forests and it is hoped that other provinces would also pay attention to this aspect of forest conservancy if they have not already done so. We know of game laws and preservation from and restriction against the all-eager arm of the hunter, but the idea of preservation of the indigenous primeval flora has been absent in the past.

Forest botany does not figure much in the provinces except in Assam and Burma, where the forest departments maintain their own herbaria under the charge of the botanical forest officer in Assam and the silviculturist in Burma. Periodical additions are being made by departmental exploration and collection of plants from unexplored and little explored areas. The importance of herbaria to the forest department is too well known to need further

comment. Suffice it to say that the herbarium is to the forester what the axe is to the wood cutter. From the absence of any reference in the report to botanical activity in the provinces other than Assam and Burma, it is presumed that the other provinces have outgrown that stage where recourse to herbarium is essential at every step in the work of the forest department. But it is a truism that there can be no stage where such a recourse to a well-equipped herbarium becomes unnecessary.

The report shows that the forest research in India is assuming considerable proportions and augurs well for the future of Indian revenues from the forest wealth.

V. N.

General Physics—by W. L. WHITELEY, B.Sc.
Published by London University Press Ltd.
1940. Pp. viii+590 with figures. Price 7s. 6d.

The book consists of five sections dealing with the fundamental principles of mechanics, heat, light, sound and magnetism and electricity. The standard of treatment of these subjects is that required for the general physics papers in the matriculation examination of London University, but the book also covers very nearly the syllabus in physics for the I.Sc. examination of Calcutta University. It however does not cover the said syllabus completely, because a few topics in heat, light and sound have been either omitted or discussed very briefly. The section on mechanics includes the whole course on hydrostatics for the I.Sc. examination. Abundance of illustrations is a special feature of this book and these illustrations will help the beginner in understanding the subject very quickly. Students of average merit preparing for the I.Sc. examination of Calcutta University with physics as one of the papers will find this book immensely useful to them. Considering the quality of paper and printing and the number of illustrations, the price of the book seems to be quite moderate.

S. C. S.

LETTERS TO THE EDITOR

Possible Earth's Field Effect On Atmospheric Spectrum Intensities

In a communication to this journal¹ there appeared a report of investigations undertaken by the writer which suggested a close correlation between band intensity variations in the absorption spectrum of the lower atmosphere when viewed in a direction horizontal to the earth's surface and, simultaneously, changes in the potential gradient of the earth's electric field at site. The hope was expressed that detailed spectroscopic studies would be undertaken immediately to establish the existence of such a relationship, but the consequent incidence of war conditions rendered it extremely difficult to carry out the work at Bombay and the experiments had to be postponed. However it is expected it will soon be possible to set up the necessary equipment in the interior of the country where night lighting restrictions do not exist and where it will be permissible to project a powerful beam of light a considerable distance from source. In view, however, of the criticism which the writer has received regarding² his hypothesis, a considerable portion of which has been constructive, it is necessary to enunciate this interesting problem afresh.

The transparency of the atmosphere at a certain place to different wavelengths of light even to very narrow limits of the same absorption band, has long been known to vary within a very short space of time, though no adequate explanation of the phenomenon has yet been forthcoming. It is reasonable to suppose, however, that the changes are due in a large measure to selective absorption by molecules of oxygen in the air. Oxygen has no bands in the blue-green and in the blue-violet regions and, therefore, did not register systematic variations in the writer's own observations¹. Intensity variations also appeared in the observations of Childs and Mecke³ and of Babcock and Dieke⁴, but have also not been accounted for. Schlapp⁵ offered a mathematical formula which implies that there occur changes in the expression λ/B , (in which λ is a measure of the cosine-square coupling between the total electron spin of the molecule and the quantized component

of the orbital electronic angular momentum along axis of figure, and B is the usual term $h^2/8\pi^2I$)—also a supposition for which there does not at present appear to be any physical justification. Subsequent work^{6,7} would nevertheless indicate that the possibility of action by a superposed electric field might well be examined as a possible cause of the intensity anomalies experienced, even apart from the writer's own deductions.

Now the earth's atmosphere may be considered as being entirely enveloped in a terrestrial magnetic, and in a terrestrial electric, field. The former is known to vary in magnitude but the change is so small that the magnetic field may be said to remain constant for our purpose. The latter, however, changes considerably and in the course of a single night may vary in magnitude from one volt per cm. to five. The atmospheric oxygen molecule likewise, may be said to have a resultant magnetic field due to rotation of the molecule as a whole and, for reasons given below, a resultant electric field.

At all times, therefore, the molecule would take up such an orientation in space as to be in the resultant of the two above-noted earth's forces acting on it. It is clear, therefore, that for a given electric field strength there would be a corresponding angle of orientation which the molecule would make with the line of direction of the earth's electric field; and for such a setting of the angle a certain group of bands or band branches would exhibit maximum intensity at a particular moment, since each group has its "own" orientation angle of maximum absorption⁸. Should the field strength now change to a new magnitude, the molecule would make a new angle with the direction of the field and a new set of intensities would make its appearance. There would thus occur changes in band or band branch intensity corresponding to the strength of the earth's electric field at a particular instant. Such a possibility has also been envisaged in the paper by Kuhn, Duhrkop and Martin referred to above and, though they used an organic liquid for their absorbing medium, the results are not vastly different if we consider the fact that they used a stronger electric

field. It is interesting to note that they observed a different intensity variation within the same absorption band, for their findings are in good agreement with those recorded by Childs and Mecke³ in the atmospheric absorption bands.

There remains only the question as to whether or not there exists an electric dipole in the atmospheric oxygen molecule, however small in magnitude. The assumption of a polar field has been made on two grounds: firstly, the existence in the immediate neighbourhood of the molecule of the powerful atmospheric water vapour dipole may reasonably be expected to induce a small electric moment in an adjacent, otherwise homopolar, oxygen molecule. Secondly, spectroscopic observations by Babcock⁴ and by Mulliken⁵ strongly suggest the possibility of the atmospheric oxygen molecule behaving otherwise than in a symmetrical, homopolar manner. Under the circumstances the assumption of a hetero- or pseudo-polar character on the part of the atmospheric molecule is apparently the only course open to us.

In conclusion the writer wishes to express his gratitude to Dr S. R. Savur for the use of the electrographs of Colaba Observatory, and to both Prof. G. R. Paranjpye and Dr N. R. Tawde for the use of the spectroscopic laboratory of the Royal Institute of Science at Bombay. Further work is proceeding.

Care of the
Colaba Observatory,
Bombay, 6-1-1941.

Alfred B. Arlick.

¹ A. B. Arlick, *SCIENCE AND CULTURE*, 5, 62, 1939-40.

² Private communications with J. H. Van Vleck, F. J. W. Whipple, and others.

³ W. H. J. Childs and R. Mecke, *Zetts. f. Physik* 68, 344, 1931.

⁴ G. H. Dieke and H. D. Babcock, *Proc. Nat. Acad. Sci. of Wash.* 13, 670, 1927.

⁵ R. Schlapp, *Phys. Rev.* 51, 345, 1937.

⁶ W. Kuhn, R. Duhrkop and H. Martin, *Zetts. f. Phys. Chem. B.* 45, 2, 121, 1939.

⁷ V. A. Johnston, *Phys. Rev.* 57, 621, 1940 (anomalous scattering in crystals).

⁸ H. D. Babcock, *Proc. Nat. Acad. Sci. of Wash.* 15, 471, 1929.

⁹ R. S. Mulliken, *Phys. Rev.* 32, 886-887, 1928.

The Analysis of Incomplete Split-plot Designs

In view of the different errors used for comparing the whole-plot and the sub-plot treatments, the analysis of incomplete split-plot designs cannot be done on lines similar to that of the ordinary incomplete experiments. The sum of squares for the main blocks, the whole-plot and the sub-plot treatments can be calculated in the usual way by fitting constants¹. The sum of squares for errors (a) and (b) together is equal to the total sum of squares minus the reduction in error by fitting constants for the effects of the main blocks and the treatment-combinations. We have now to calculate the errors (a) and (b) separately.

To calculate the sum of squares for error (b), (i.e., error appropriate for comparing the sub-plot treatments and the interactions) we split up the whole experiment into as many hypothetical simple experiments as there are whole-plot treatments by grouping similar whole-plot treatments of the different main blocks. The sum of squares for the residual error with the respective degrees of freedom for every one of the hypothetical experiment (complete or incomplete) is calculated after making allowance for the blocks and the sub-plots treatment effects. It can be shown that the totals of the sum of squares and the degrees of freedom of the residual error of all the hypothetical experiments are equal to the sum of squares and the degrees of freedom for error (b). Knowing error (b), error (a) can be easily calculated from the sum of squares for errors (a) and (b) together which has already been estimated.

P. V. Krishna Iyer

Imperial Agricultural
Research Institute,
New Delhi, 29-11-1940.

¹ *Proc. Ind. Aca. Sci.*, 11, 369-375.

Mathematics and Statistics

Functional Analysis and Mathematical Physics

M. RAZIUDDIN SIDDIQI

A VERY important problem of mathematical physics is the unification of various theories connected with the different branches of this science. The task demands the creation of very powerful tools of mathematical analysis. Such tools have been developed since the beginning of the present century, and consist of the various topics in functional analysis.

The considerations of Abel and Liouville in the early part of the 19th century gave rise to a vast number of inversion formulae for definite integrals which were later called "Integral Equations". Volterra, Fredholm and Hilbert developed since 1900 an extensive theory not only of the solution of integral equations, but also of the eigenvalues and of the Fourier-expansion in series of eigenfunctions as well as that of application to mathematical and physical problems. Integral equations have now become indispensable in many theories in geometry, analysis and the whole domain of mathematical physics. The modern theories of ordinary and partial differential equations cannot be conceived without the theory of integral equations. Direct applications of this theory, without the mediation of differential equations have been made to statistics, kinetic theory of gases and the theory of radiation.

It is now recognised that evolution is not only of the non-hereditary character dealt with in classical mechanics and physics. These classical theories were based on the principle that the present state of a system determines all its future states. This determinism is a consequence of the conception that each action manifests itself only at the instant when it takes place, and leaves no heritage. This is the same thing as the assumption that the system does not conserve the memory of those actions which have affected it in the past. But all the phenomena of nature are not really produced in this way. There are a number of evolutionary phenomena in which

heredity and memory play an essential role, and to which the theory of differential equations cannot be applied. The analysis proper to such phenomena is that of integro-differential equations.

When the theory of linear integral equations was built up in close analogy with a system of linear algebraic equations, it was natural to enquire whether the considerations could not be extended to non-linear integral equations. Such extensions have been made for solutions "im-Kleinen" as well as "im-grossen", and Levi-Civita's problem of the propagation of 2-dimensional surface waves of finite amplitude, Carleman's problem of the theory of heat radiation, the inversion problem in the theory of functionals, the equilibrium figures of rotating fluids, the dynamics of incoherent gravitating media, etc., can only be treated with the help of non-linear integral and integro-differential equations.

For the further development of functional analysis the introduction of the principle of passing from finite to infinite into the theory of determinants was of considerable significance. This made it possible to build up a theory of infinite systems of algebraic equations in complete analogy with the theory of finite systems. Thus originated the idea of functions of an infinite number of variables. Hilbert developed a systematic theory of infinite linear, bilinear and quadratic forms, and deduced from this the whole theory of solution and the theory of eigenvalues of integral equations. Hilbert's theory of infinite bilinear and quadratic forms provided also a very powerful method for the treatment of boundary value problems for ordinary and partial differential equations. A theory of infinite matrices and of principal-axes transformations was also developed which supplied the mathematical foundations for modern quantum mechanics. The geometry of Hilbertian space has been applied to formulate

the generalised absolute differential calculus which includes Ricci's tensor calculus as a particular case.

Apart from mathematics, functions of infinitely many variables have an important bearing on natural philosophy. If we consider a phenomenon as the effect of a finite number of causes, we are making only an abstraction because we are neglecting elements which are supposed to be very small compared to others which are taken to be preponderant. In this way we make only an approximative study of the phenomenon, for a full and complete study of which it would be necessary to pass from a finite to an infinite number of variables.

From a consideration of the variation problems, Volterra was led to 'functions of lines' which are now called—"functionals". Functional analysis has developed along various lines corresponding to those of the theory of ordinary functions. It has penetrated deeply into the various branches of pure and applied mathematics. Everything concerning integral and integro-differential equations, investigations on functional spaces, the calculus of variations with its diverse applications in mathematical physics, questions involving effects of hereditary type—all these different subjects have now been unified in one general theory of functionals. Moreover, the functional method gives us a ready criterion for examining whether the various expressions for natural laws are in an invariant form agreeing with modern relativistic conceptions.

Recently, a general analysis has been developed in which the concrete variables of the infinitesimal calculus have been discarded, and relations are studied between two elements of any nature what-

soever. This new analysis proceeds by making an abstraction of all those concepts which are common to several known and allied theories. These are then generalised by removing from them any particular properties that are related to the concrete elements on which they are based. This has given rise to the general theory of "functional operators" which has now become an essential part of many of the most important domains of mathematics. In it we see the methods of classical mathematics blending harmoniously with those of modern mathematics, bringing about a certain unity in different branches sufficiently remote from each other. A really profound insight into many important branches of mathematics such as the theory of functions, integral and integro-differential equations, calculus of variations, theory of sets, topology and theory of dimensions is possible only with the help of functional operators.

Modern theories of physics make much use of the operator calculus. Thus, apart from classical mechanics and electro-dynamics, the subject of quantum mechanics in its modern developments is based entirely on the theory of linear operators. This theory plays the same part in quantum mechanics as tensor analysis plays in relativity mechanics. Quite recently the quaternionic operators have been applied to relativistic quantum mechanics.

Functional analysis has developed extensively during the last few years, and has penetrated deeply into mathematics, mechanics, mathematical physics, statistics, biology and sociology. It is one of the most powerful tools of research in contemporary mathematics.

Chemistry

Physico-Chemical Studies of Gels

MATA PRASAD

THE address gives an account of the various properties exhibited by several types of gels and of the theories which deal with their mode of formation and their structure. In India most of the work on the subject has been done at the Royal Institute of Science, Bombay, and at the University of Allahabad. Prasad and co-workers have prepared a number of gels in a transparent state and have made a systematic study of their time of setting and the changes in the viscosity and the optical properties during the process of gelation. This study has contributed a good deal to the elucidation of the mechanism of the formation of gels. A new apparatus has been devised at the Institute to measure directly the changes in opacity taking place in gel-forming systems during the process of setting.

The earlier part of the address is devoted to a discussion of the terminology and the classification of gels into organic, inorgano-organic and inorganic, and the reversible transformation into sol which some gels undergo on changes of temperature or on account of mechanical action (thixotropy), or freezing (cryotropy) or desiccation.

Time of setting is the main property which characterizes an inorganic and some inorgano-organic gels. It is very sensitive to small changes of conditions of preparation, such as that of concentration, pH, and temperature and that of the addition of any extra substance, either an electrolyte or a non-electrolyte. The setting of gels follows the laws of ordinary chemical reactions and the time of setting measures the time when a certain stage in the process of gelation is reached. This conception permits the application of Arrhenius's equation in the calculation of the heat of activation of setting.

Suggestions have been made with respect to the definition of the time of setting in the case of organic gels. Some measurements made according to the definition have shown that Arrhenius's equation is applicable to these gels as well.

The character of thixotropic gels can also be studied by the determination of the time of setting. However, the determination of the coefficient of

thixotropy has been made by Goodeve and Whitefield by the measurement of the viscous behaviour of these gels.

The microscopic and ultra-microscopic examinations of most gels have revealed that they are optically empty but considerable information regarding their structure has been obtained by a systematic study of their elasticity, viscosity and optical properties and the phenomena of syneresis, sorption and desorption and diffusion. These studies have led to the conclusion that gels are diphasic systems consisting of a liquid and a solid phase, both phases being continuous. The liquid phase is probably a solution of the gel-forming substance in the dispersion medium; the solid phase is highly solvated with the liquid phase and forms fibrous structure which encloses the liquid in its pores. The liquid phases which solvate the solid and that which fills the interstices of the fibrils have been, respectively, considered as fixed and free.

The forces which bind the fibrils together are of the nature of residual affinities and they continue to act even after the gel is set. The exudation of liquid in syneresis and desorption, the sorption and imbibition of liquids, vapours and gases by gels and diffusion of liquids through gels take place through the capillaries of the fibrils which have been found to be distributed at an interval of 100 millimicrons in the body of gels. The micelles which go to make up the threads are anisometric and non-spherical and are regularly orientated in thixotropic gels.

Poole has recently developed the mathematical theory for the behaviour under stress of a structure composed of a mesh of cylindrical threads and has found that the experimental elasticity-temperature-concentration curves are approximately in quantitative agreement with the theory.

The address concludes with the remarks, "Thus the fibrillar theory explains most of the properties of several gels and has consequently received the adherence of most workers on the subject. However it cannot be assumed *prima facie* that all gels have the same architecture".

Botany

The Respiration of Plants in Light

SHRI RANJAN

IN the case of non-green leaves of croton containing carotinoid pigments and the flowers of *Bougainvillea* and *Nerium*, their respiration rate in light appreciably increases. The respiration rate of a green leaf also increases in light but due to photosynthesis the respiration rate is affected. Therefore to find out the true rate of respiration of a green leaf in light one should study the dark respiration after a period of illumination. The respiration rate of this dark period at first increases up to a point and then decreases. If this falling curve is produced backwards to the point when light was cut off or to the zero hour of darkness, then the respiration curve of darkness will show an L shaped fall. The high point touched at the zero hour of darkness is the respiration rate in light while in darkness the respiration rate steadily falls off. This steadily falling off of respiration curve is similar to the "floating respiration" of Blackman which is nothing else but the "after effect" of light. The following scheme for light respiration is suggested.

HYDROLYSIS

Carbohydrates $\longrightarrow n(\text{Glucose}).$

Primary Reaction (photochemical or thermal)

2 Glucose + $h\nu$ \longrightarrow Glucose' + glucose.

Secondary Reaction (thermal)

Glucose' + En. \longrightarrow 2 $\text{C}_6\text{H}_{12}\text{O}_6$ + q

2 Glucose + q \longrightarrow Glucose' + glucose.

Glucose' + En. \longrightarrow 2 $\text{C}_6\text{H}_{12}\text{O}_6$ + q

N. B. En = Enzyme.

$q = h\nu$ —the difference of the energy between $\text{C}_6\text{H}_{12}\text{O}_6$ and $\text{C}_6\text{H}_{10}\text{O}_5$.

$h\nu$ —is the photonic energy (h is Planck's constant, ν the frequency of light).

The above scheme of reactions suggests at least two reactions involved in respiration.

(1) The primary reaction which is both thermal and photochemical and (2) secondary reaction which

is purely thermal. Further support is given to the above scheme of reactions by the work on the temperature effect upon respiration in light. It has been found that in the case of *Eugenia* leaves—which is a tropical plant—the maximum rise in the respiration rate in light is at 27°C . This increase decreases with higher or lower temperatures. Now, according to the above scheme, let us suppose that in the chain of reactions $\text{A} \longrightarrow \text{B} \longrightarrow \text{C}$ the 1st reaction i.e., A to B is photochemical and B to C chemical. The rate of B to C will depend upon the rate A to B.

In dark at 20°C both A to B and B to C are slow and the rate of respiration is consequently slow. If light is given A to B gets accelerated while B to C remains slow. Thus the reaction is limited by the rate of B to C.

At 27°C the rate of respiration augments in light because B to C is no longer limiting.

Now as the activation of the reacting metabolites in the primary process can be brought about both by light and temperature, then if the temperature is greatly in excess a large number of molecules will already be in an activated state and with light the increase in activation will be proportionately less. Thus the increase in respiration proportionately decreases in light beyond 27°C .

The increase of the primary process or the increase of respiration in light will only take place, if the respiring organ is coloured. Colourless plants like fungi or the roots of plants show no increase in respiration in light, for the simple reason that light of the necessary frequency is not absorbed.

On this scheme the falling respiration curve of leaves which is called the floating respiration by Blackman is really the 'after effect' of light. Because the energy q given out in the reaction is enough to activate a second molecule of sugar and light energy after the first reaction, the value of $h\nu$ will not be required. Theoretically the reaction once commenced in light should go on at the enhanced rate in darkness, but due to the gradual dissipation of energy q the respiration in darkness comes down to a slower rate.

Entomology

Some Observations on the Periodicity of Locust Invasion in India

Y. RAMCHANDRA RAO

TILL the beginning of the nineteenth century there were no definite records of locust infestation in India, and Cotes (1891) has collected much of the available information from 1800 to 1869. From 1869 fairly definite information is on record. The outbreak of the desert locust of 1926-31 is very fresh in memory. It occurred simultaneously over large areas of south-western Asia and north and central Africa. In the African area, two other locusts—the Tropical Migratory Locust (*Locusta migratoria migratorioides* R. & F.) and the Red Locust (*Nomadacris septemfasciata* Serv.) were also active, over very large areas.

SOME OF THE IMPORTANT LOCUSTS OF THE WORLD

There are several species of locusts in the world, one of the most well-known of which is the Migratory Locust. This locust has developed into distinct races adapted to different types of country. The European form is adapted to a cold climate, while the Tropical Migratory locust and the Malagasy locust are both suited to tropical conditions. The race found in the Philippines, China and Malay Archipelago is the East Asian form, while the one found in India is only exceptionally found in the gregarious condition.

The Desert Locust (*Schistocerca gregaria* Forsk.) is the locust of the Bible and is the most important one in North Africa and South-west Asia. Other locusts of major status are the Bombay Locust of Deccan, the Red Locust of Africa, the Brown Locust of South Africa, and the Moroccan and Italian locusts of the Mediterranean region. Australia is subject to the periodical outbreaks of two grasshoppers (*Chortoicetes* and *Austroicetes*). In South and Central America, and in Mexico, the South American Locust (*Schistocerca paranensis* Burm.) is the dominant species.

Of these locusts, a good many have only one brood in the year, of which some, like the Bombay Locust, the Red Locust and the South American Locust, pass the greater part of the year in the adult stage, while in other species, such as the European, the Moroccan and the Italian Locusts, their eggs lie in a quiescent condition in the soil during the greater part of autumn and winter.

In all these cases, an increase in numbers is usually gradual and is dependent on a succession of favourable years. On the other hand, in the case of the Desert Locust, the Tropical Migratory Locust, the Brown Locust and *Chortoicetes* of Australia, the egg stage is short and normally two or more broods may be produced in a year. These species are most dangerous from the point of view of swarming, as they are able to pass through successive broods quickly, and, in case conditions are favourable for concentrated breeding, also to form the incipient swarms rapidly.

PERIODICITY OF LOCUST OUTBREAKS

In the case of the three species of locusts found in India, the Migratory Locust very rarely forms swarms. An instance of heavy infestation in 1878 in the southern districts of India is on record, and recently an outbreak was reported in 1937 in the Rajputana-Kathiawar area. Except for these cases, it is usually found in the solitary phase. The Bombay Locust is endemic in the areas of the Western Ghats, and usually visits the neighbouring districts of Bombay, but in years of heavy infestation its swarms may invade districts of the United Provinces, Central India, the Central Provinces, Bihar, Hyderabad and northern Madras in addition to Bombay and Gujarat. Swarming is known to have occurred in 1835-45, 1864-66, 1878-84 and 1901-08. The Desert Locust is the locust *par excellence* of India not only by the frequency of its visitations, but also by the

extent and severity of its attacks. It is usually confined to the north-western parts of India, but at the height of its outbreaks its swarms may reach as far east as Assam and as far south as the north of Madras.

PERIODICITY OF THE DESERT LOCUST IN INDIA

Only scraps of information are available for the period from 1800 to 1860. Destructive activities of swarms on record refer to the years:—1803; 1810-13; 1821; 1826; 1833-34 and 1843-45. Locusts are known to have invaded Egypt in 1855, but there are no data for India at this time. Between 1860 and 1940, the following were the periods of locust incidence:—1860-66; 1869-73; 1876-81; 1889-98; 1900-07; 1912-19; and 1926-31. There were thus locust cycles of 5 to 9 years each, with only short swarm-free intervals 1 to 4 years each, (except in 3 cases where they lasted 6, 7 and 8 years).

Till careful observations were made during the recent interval of 1932-39, there was little information as to what was happening to locusts during the period when swarms disappeared. These investigations have shown that locusts continue to exist during such periods in a non-gregarious form, distributed among the scrub vegetation of deserts in small numbers. The solitary locust reacts to changes in the weather in much the same way as the *gregaria* locust, and similarly has two broods in the year,—first in the spring months in the winter brood areas, whence the new generation migrates at the beginning of summer into the summer-rain areas of the Rajputana desert, and breeds in the monsoon months. The new generation produced here migrates in autumn into the winter-rain areas, where breeding occurs in the spring of the following year. It was also observed that the solitary locusts are able to transform into the *gregaria* swarms whenever, in the wake of favourable rainfall, two consecutive broods are rapidly produced, and crowded breeding is brought about under conditions of concentration.

GENERAL COURSE OF A LOCUST CYCLE IN INDIA

A close study of the data of the last outbreak shows that the activities of swarms may be classified under (1) over-wintering, (2) spring-breeding and (3) summer-breeding.

(1) During the winter months, swarms become scattered among the vegetation in areas where they happen to be present at the onset of winter. Over-wintering usually occurs in the southern parts of Mekran, in Sind, in Kachhi and in south Punjab.

(2) When spring ushers in warm weather, they become active again and in case of good winter rainfall, may begin to breed. In March, a general migration of swarms northwards into the mountain valleys of Baluchistan commences. The swarms gradually work their way up to Chagai, Sarawan, Quetta-Pishin and Zhob, and ultimately into the North-west Frontier *via* Afghanistan. Breeding occurs in these areas in April, May and June, and the new brood migrates eastwards into the Punjab, Sind and Rajputana in May, June and July. Breeding also occurs in the Punjab in spring, whence the new brood moves eastwards into the United Provinces, Bihar and Bengal in May-June.

(3) With the fall of monsoon showers, the swarms arriving from the western areas begin to breed in the Punjab, Sind, Rajputana and the United Provinces, wherever conditions are favourable. In case good rainfall is received in August-September, a second generation may be produced; otherwise, there is only one brood. With the withdrawal of the monsoon current, North-west India (especially the desert area) becomes an area of drought in September-October, and swarms produced here tend to leave the area either eastwards into United Provinces, Bihar and Bengal, or southwards into Gujarat and Bombay or westwards into Sind and Baluchistan, according to prevailing winds. It is, however, only those that reach the Baluchistan and Iran areas that can breed again in spring; others die away ultimately.

Reviewing the actual sequence of events in the 1926-31 cycle, it is seen that the absence of westward migration in the autumn of 1928 as well as a partial drought in the spring of 1929 in Mekran might have resulted in a break-down of the infestation, had it not been for the influx of swarms of Arabian and Persian origin in April-May and their breeding in parts of Upper Baluchistan. The new generation migrated into Sind, the Punjab and Rajputana and gave rise to heavy multiplication in the monsoon period. Pronounced west-bound migration in autumn (1929) was followed by intense breeding in the Mekran area in the spring of 1930, which marked the peak of the outbreak. Failure of rain in August and September caused an early cessation of breeding in the desert, and most of the swarms migrated east and south. There was very little of westward movement in autumn (1930). Light breeding in spring 1931 and only partial multiplication in summer, followed by winter drought in Mekran in 1932, brought the cycle to a close.

ORIGIN OF NEW CYCLES OF LOCUST INFESTATION

Observations made in 1935 showed that large outbreak centres were produced in late spring in the hinterland of Mekran and that the new brood migrated in July into the desert area, where, however, owing to deficient rainfall in August, swarm production did not occur.

In 1926, on the other hand, owing to well-distributed rainfall in the monsoon months, heavy multiplication occurred in the desert, especially in the south, and resulted in the production of large swarms, which brought the 1926-31 cycle into existence. In the case of the present outbreak (1940), multiplication commenced as early as last spring (1939) in Mekran in the wake of very favourable winter rainfall, but owing to the initial population being low, the increase in numbers was, apparently, not noteworthy, and as the monsoon in the desert areas was almost a failure the monsoon brood was also poor. The winter-spring rainfall of 1940 in Mekran was fairly good, but so far as observed did not result in any remarkable breeding. The initial numbers of locusts found in summer in the desert was fairly high and possessed rather high phase ratios. It is also presumed that they became concentrated in the patchy vegetation caused by the previous year's drought. Crowded breeding ensued especially after the heavy showers of August and caused the re-appearance of swarms after about 8 years.

IMPORTANCE OF CHECKING THE INITIAL OUTBREAKS

In India danger points lie in British and Iranian Mekran in regard to spring breeding, and in the

Indian desert areas in respect of summer breeding. At present, however, no co-operation has yet been secured between Iran and India in regard to the watching of the outbreak areas in the west. For want of funds, it was not possible to check the incipient swarms that were detected in the Indian desert areas. Though swarms have re-appeared this autumn, it is hoped that by necessary control measures, further infestation may be checked.

SUNSPOTS AND LOCUST CYCLES

Various authors, such as Swinton, Criddle, Uichanco and Richmond have traced the fluctuation in the numbers of locusts and grasshoppers to variations in the numbers of sunspots and have found an inverse correlation between them. The multiplication of locusts and grasshoppers is apparently highest when the sunspots are at the minimum.

NEED OF FURTHER RESEARCH ON LOCUSTS IN INDIA

To check future infestations the initial outbreaks should be detected and checked in time. To achieve this object, it is necessary that the organization designed to undertake this work should be equipped with adequate staff and funds, and all expense incurred by the Government would, after all, be a sort of crop insurance for the Indian ryot.

It is also necessary a stimulus should be given for the initiation of more investigations in these matters now that swarms have re-appeared, and more than all, there is a need for the assurance of a continuity of support even after the swarm vanish.

Anthropology

Cultural Anthropology in the Service of the Individual and the Nation

T. C. DAS

ANTHROPOLOGY is commonly believed to be a border-line science which has practically no application. This misconception is due partly to lack of knowledge of the scope of and recent advances in anthropology on the part of the ordinary man and partly to the anthropologists themselves who have in the past laid too much emphasis on the historical side of the subject. But recent trends in both physical and cultural anthropology show a definite change in the angle of vision and the study of the present is seriously replacing that of the past.

Cultural anthropology is the direct product of contact between European nations and the coloured people of the earth. The early traders, soldiers, missionaries, planters and administrators required knowledge of the alien people among whom they were placed and they recorded the manners, customs, beliefs and superstitions of these people in order to understand them properly. Cultural anthropology is based on these observations of the practical men.

PLACE OF ANTHROPOLOGY IN TRADE, INDUSTRY AND AGRICULTURE

Trade, industry and agriculture are the three most important institutions of modern man. In finding a market as well as in keeping it, when found, the trader has to learn the habits, ways, predilections and prejudices of the people among whom his business lies. Many of our local industries have paid dearly for negligence in taking into account the needs of the people, their tastes and purchasing capacity. The lac ornaments of Chota Nagpur have practically disappeared with Japanese imports. Brass and bell-metal industry of Bengal is on its last legs. Minute knowledge is necessary to note the various circumstances which lead to the growth of new fashions, modifications of old ones and disappearance of ancient usages. In this task the services of the anthropologists are

essential and the science of anthropology has an important part to play.

Besides supplying information to the trader and industrialist about their markets the anthropologist can help them in other spheres too. Modern big-scale industries and farming employ labour mainly recruited from tribal people and submerged classes. Labour troubles are growing more and more acute in India. It is in certain cases due to the ignorance of the employers about the life and traditions of these people and consequent unsympathetic attitude. There is also the lack of contact of these labourers with their own people and consequent absence of controlling agencies like the family, or clan and village elders who exercise a judicious check over individual inclinations in their homeland. This aspect of the industrial problem requires specialised study by the anthropologists.

ANTHROPOLOGY IN LAW AND LEGISLATION

Administration of law and legislative activities are intimately connected with anthropological knowledge. Especially in primitive areas or places where the officers of law have different tradition and culture, anthropological knowledge becomes imperative. Primitive notions of life and law often differ diagonally from those of the civilised. Thus, the law of limitation is unknown among many tribes of Assam and marriage by force is a common feature of the tribal culture of Chota Nagpur and Orissa. Magico-religious concepts are also sometimes responsible for perpetration of crimes. If these cases are judged strictly on the basis of civilised notions of their gravity, justice will not be dealt out fairly. The attenuating circumstances must be taken into consideration and this leads the judge and the lawyer towards anthropology. Anthropological knowledge has pointed out in Africa how legislative measures may be introduced among tribal groups with the least disturbance of their life and culture.

In social legislation also results have been very unsatisfactory where the laws have been hastily drafted without any reference to the conditions prevailing and without calculating the effect that the alteration of the social codes will produce. The census reports are officially regarded to be the depositories of all kinds of knowledge necessary for introducing such measures. We have a number of such Acts on the Statute Book which are mere dead laws, as for example, the Widow Remarriage Act and the Sarda Act. These half-hearted measures not only retard future progress but also lull into quiescence the spirits of change and progress. Society is, as it were, a huge organism. If you strike it at any one part all the other parts feel and react. So, socio-religious legislation should be based on and guided by the opinion of anthropologists who alone are acquainted with the linkage of cultural elements. This is equally true even in economic spheres.

ANTHROPOLOGY IN EDUCATION

Educating the primitive is a dangerous task. In culture-contact areas it assumes even greater complexities. Education is more potent than even the direct attacks by the State and economic factors as it moulds native institutions, standards of living, moral codes and inherent values. The type of education suitable for these people is unknown to the ordinary educationist and the advice of the anthropologist is indispensable in such circumstances. Besides helping to find out the proper type of education to be imparted to a primitive group anthropology may also assist in creating suitable teachers for such areas and this is equally important. Love and respect for the teacher is aroused in the student by a sympathetic attitude of the teacher and sympathy is born of knowledge. Anthropology supplies this knowledge.

ANTHROPOLOGY AND SOCIAL SERVICE

In recent years a number of philanthropic or religious missions have sprung up in India among the children of the soil. They are weak imitations of European or American Christian Missions. Missionaries introduce new ideas about social behaviour, political thoughts or religious beliefs and practices. The established order of the community is attacked at different points—points which are comparatively more vulnerable. They represent, in a word, disruptive forces. The less advanced the community, the more exposed it is to the preachings of these missionaries. Human society is just like a

chain of links. If you attempt to remove one, the others are also forcibly displaced. When the missionaries, with the best of intentions, try to introduce an apparently beneficial reform they unconsciously pull at one of these links and thereby the whole social order is often upset. Thus the Christian missionaries' attempts to stop brideprice and polygamy in Melanesia practically upset the order of society. In their zeal for conversion, the missions often lose sight of their ultimate aim. Thus the Christian missionaries, instead of making it their life's work to carry the message of universal and eternal love to the suffering humanity which the Son of God was commissioned to bring to this world, spend all their energy in inducing people to go through the ritual of baptism. Such conversions are not the effect of convictions but are occasioned by worldly inducements. The *en masse* conversion of Harijans in different parts of India prove the truth of this charge. Often again Christian missionaries try to introduce European customs in place of African or Polynesian ones. To what extent this system of denationalization run can be gathered from the fact that in certain parts of Africa "not a single African leader considered it possible for anybody to be at once a Christian and an African".

Fortunately, we hear, there is a change in the attitude of the missionaries. They have realised the existence of valuable traits in native culture and are now trying to make a synthesis of European and local cultures through the schools and missions. This new attitude demand closer co-operation with anthropology. Sublimation of local traits needs careful research into the nature of local institutions and beliefs whose essence is proposed to be conserved in the new synthesis. This, no doubt, pushes the missionaries into the embrace of the anthropologists for help in discovering the vital elements of culture. Already the Protestant missionary societies have established their own Department of Social and Industrial Research. The International Institute of African Languages and Cultures owes its origin to a group of missionaries and their friends. Missionaries on furlough now attend lectures on anthropology and already there are in the field a number of academically trained anthropologists in the service of the different missions. The Indian missionaries should take their lessons from their Christian brethren and Indian universities should make arrangements for training in social service with anthropology as its basis.

ANTHROPOLOGY AND ADMINISTRATION

In India, out of a total population of a little over 352 millions, according to the last Census

operations, we have more than 22 millions of tribal people, or in other words, out of every 16 persons one is an aboriginal. Both the Government of the country and the educated public have at least a moral responsibility to ameliorate the condition of these 22 millions of wretched souls. The Indian aboriginal has to fight with two sets of exploiters—the foreigners and the advanced Indians. They require protection from both and the Government of India Act 1935, has partially recognised this requirement. There are provisions in this Act to safeguard their interest. But these provisions are neither complete nor satisfactory. They may stop the direct approach of the advanced Indians but are absolutely useless against the foreign exploiters. A stupendous experiment in applied anthropology is going on in Africa. The establishment of indirect rule in different parts of Africa such as Nigeria, Anglo-Egyptian Sudan, Gold Coast, Northern Rhodesia, Nyasaland, Camerouns, Togoland, etc., owes much to anthropological knowledge. The work of the fellows of the International Institute of African Languages and Cultures as well as of the Rhodes-Livingstone Institute show the value of anthropological knowledge in practical administration. The Report of the former claims that "The Governments, indeed, of some of the territories in which the fellows have worked have shown themselves anxious to obtain their further services". In the Pacific region too Dr Raymond Firth has shown one generation ahead how in Tikopia the "traditional equilibrium between population and food supply" will be upset by the actions of the Government and the missionaries. These experiences of other lands should be utilised in India. For this purpose, at the first instance, a thorough anthropological survey by

specialists is necessary. This is to be followed by employment of officers with anthropological training who will keep themselves abreast with the changes in the cultural make-up of the people over whom they are placed and thereby keep the records of the specialists up-to-date. As a rule all officers of the State to be employed in the tribal areas must have either previous anthropological training or arrangements should be made to give such training after appointment in or transfer to such tracts. This will diminish the chances of maladministration. This is how anthropology can be applied in administrative affairs.

CONCLUSION

So long our picture included mainly the primitive or the backward people. But anthropology is not concerned with them alone. The Functional School of Anthropology has demonstrated without leaving any scope for doubt, that it can be applied with equal force in solving the problems of civilised life. Anthropology is no longer concerned with the savage only.

Analysis of culture can only be undertaken by trained anthropologists, who are best equipped to do it. Questions like female emancipation, dismemberment of the joint family, dying out of the artisan castes and decay of the middle class—to mention a few only—are causing anxiety to the best minds of India. Each and every one of them is a vital question affecting the whole social organism and they should not be left to amateurs and enthusiasts for solution but must be tackled by properly trained scientific men.

*Note:—*With a view to giving our readers authoritative summaries of the presidential addresses at different sections of Science Congress, we depend on the respective presidents. They supply advance copies of summaries of their addresses to the Indian Science Congress Association, who in turn distributes them to the press. This time however we were not favoured with advance summaries of some of the addresses. In publishing the above summaries we could not therefore arrange the sections serially. We have printed as many of the available summaries as were possible in one issue, and expect to follow up subsequent issues.—Ed. Science and Culture.

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Science in War

A BOOK under the above title published in the *Penguin Series* has been lying on our table for some time past.* We are told in the preface that the book owes its origin to an informal discussion amongst 25 eminent scientists of England who gathered round a dinner table. They were not satisfied with the way in which the British Government was making use of science and scientists for the prosecution of the war and decided to voice their 'constructive criticisms' in the form of a booklet. The difficulties of writing on these subjects are obvious. It was not possible for the writers under the conditions of the Official Secrets Act to reveal their mind completely or give out their views clearly on many important points, specially on those dealing with important phases of military preparations or actual weapons of war. But on points on which criticisms could be freely expressed they have been extraordinarily frank and outspoken. We consider it a most timely publication and every scientific worker should go through this little book.

The main thesis of the book is that Great Britain even nine months after the declaration of the present war, had not learnt properly the lessons of the last Great War and had failed to make sufficient use of

science. They begin with an examination of the role of science in a life and death struggle like the present one. According to the authors:

"Science, it cannot be urged strongly enough, is something which does not stand outside the ordinary ways of acting and thinking. It is simply the most orderly expression of those ways. There is therefore a greater need for science in the present situation than there ever has been in the quiet days of the past. It is not sufficient merely to use science to solve problems that are seen to exist. What is much more important is to use science to discover what the problems are and what is their order of importance. . . . Science is also required in the general task of surveying the whole field of needs in war, and for indicating the best directions in which efforts should be expended".

Thus not only should science be more liberally employed by this or that department for particular problems but a scientific approach is needed to the problem of war in its entirety.

The review covers the whole field of armaments (of course, as far as censorship would allow), care of the wounded, problems of supply of food of proper calorific and vitamin value for the military and civil population, questions of rational agriculture, rationalization of industries with proper emphasis on the health and comfort of workers, maintenance of morale and organisation of scientific research. In the first few pages there is a sketchy account of some of the contributions of science in the field of warfare e.g., combating new weapons, invention of substitutes and conquest of typhoid and typhus, etc. In the subsequent chapters we find a full and frank criticism

* The book appears to have been published in England early in June last year, but owing to war-conditions it reached this country much later in the year. The few copies sent out here were soon sold out, and we had some difficulty in finding one for our own use. The review is therefore somewhat belated but needs no apology on account of the importance of the subject.

of the British Government's failure to deal with the vast majority of war problems and suggestions of how some of the failures may be remedied by using science not only exclusively on the technical side of warfare but also on the more vitally important questions of policy, strategy, tactics and morale. It is not as yet appreciated that the use of weapons devised by science and the organization of the men who handle them are as much scientific problems as is the production of weapons. Many of the factors in military operations may be subjected to direct scientific analysis, and though the ultimate answer as to whether these operations actually yield the expected results or not is provided by victory or defeat, scientific analysis brings to light the factors contributing to that victory or defeat and the degree to which each contributes, thus making it easy to organize for future operations. As an instance, the writers mention the problem of defeating the German tanks which might have been tackled in a scientific way on the lines already discovered by the trial and error methods of the Republicans during the Spanish Civil War. But these lessons were not learnt by the military authorities on the Allied side. The failure of the British and French anti-tank measures during the recent campaign in Belgium and France "could have been predicted and was in fact predicted". Another acute problem, namely, that of camouflage was tackled by the British Government in such a non-scientific way that it called forth a good deal of criticism from scientists of eminence. A scrutiny of the personnel engaged at the Civil Defence Camouflage Establishment revealed that more than 90 per cent were professional artists and none had attended a course in the science of camouflage. Not a single member of the establishment was a qualified biologist though many well-defined principles of camouflage are known to have been derived from researches in biology and psychology. *Nature* was constrained to remark: "Under the present system, the men who know best what should be done seem to be excluded from getting anything done. Unless and until the fundamental biological principles are understood and applied by the authorities, attempts at camouflage are merely ridiculous".

The needs in present-day warfare include not only adequate production and supply of actual weapons of war, such as arms, aeroplanes and explosives, but also the maintenance of the tenor of life of the military and civil population by protecting against blockades and closing of trades routes. In

the last war neglect of these needs led to disaster and untold misery of the civilian population. This happened not only in the Allied countries, but in enemy countries as well. We are told that in Germany during the last war little attention was paid to the problems of nutrition, the diets being deficient in calories and lacking in vitamins. "Germany collapsed", we are told "not only because of shortage of food, but also because her Government failed to realize the importance of vitamins and the people therefore became riddled with disease. The morale of the population fell, deficiency diseases (rickets, scurvy, war-dropsy and the like) became prevalent and though food shortage had brought her near to capitulation earlier vitamin shortage was the most important cause of the collapse of the home front in Germany in 1918".

The position was not much better in the British Isles and the other Allied countries. "In Italy the army was underfed, morale declined, health was undermined and this inadequate nourishment played a large part in the rout of Caporetto". We are told that owing to lack of vitamin C, scurvy broke out in the civilian population as well as amongst the army in Mesopotamia and the tragedy of the siege of Kut was more due to outbreak of scurvy amongst the defenders than to the valour of the Turks.

But this time Germany has fully grasped her food problem and the pendulum seems to have swung to the other side. According to Professor Drummond, "The German Government are alive to the importance of nutrition and are issuing vitamin supplements to all the children". But according to the authors of '*Science in War*', the British Government were till recently doing nothing like that. An advisory committee on nutrition was set up nine months after the declaration of the war. Even then it was apprehended that its advice might not be taken, as business interests conflict with the application of scientific discoveries in the Ministry of Food. Though war requires self-sacrifice of the highest order from all ranks, vested interest is the last to be shaken by it. According to our authors:

"Scientists emphatically recommended the Board of Trade not to restrict the importation of fruit, but the official view in Whitehall was that oranges, lemons, and apples were dispensable luxuries. In December, 1916 Lord Devonport became Food Controller. He had made a fortune in dealing with food, and was therefore a man of great practical experience, but he was reluctant to accept advice from scientific experts and in consequence some of his statements

were scientifically false. In May, 1917 the most authoritative body of scientists in the country, the Food (War) Committee of the Royal Society, declared that "the public announcements of the Ministry from the first appeared to show a neglect of relevant scientific principles", and entered "an emphatic protest against those parts of the Food Controller's policy which, in their opinion, are paving the way for disaster". In fact the government had not learnt the lesson which Captain Cook taught us a hundred and fifty years earlier."

The twenty-five scientific men have expressed their opinion of methods followed by the British Government even in times of this crisis in no uncertain terms. A general and organized scientific approach to the problems of national existence, according to them, is foreign to the tradition of the economic and political management of their country. They remark that the Government departments run by civil servants and by executives of large industry, acquire many of the permanent civil servants' characteristics; and what are these characteristics? According to our authors:

"The tradition of civil servants belongs to the age of Victorian Liberalism and is one of *laissez faire* and of Government non-interference. The whole tradition tends to prevent things being done. An even more serious objection is that high administrative officers have a classical training and are almost completely ignorant of technical matters. Having little conception of what scientific research is, they fail to see how it can be practically used. In technical matters they rely on their permanent technical advisers who, for various reasons, are not infrequently cut off from the more active streams of scientific thought. There is also usually a complete lack of initiative within the civil service itself, due perhaps to the cautious desire not to make mistakes. And over the whole system lies, first, the blight of treasury control—the fear of allowing expenditure that may be difficult to justify and, second, the knowledge that failure to act rapidly and decisively is not the responsibility of the civil servant, but of his minister."

The fundamental weakness of the situation, according to these scientist-authors is due more to want of able and honest direction than to any lack of human effort. No efforts however heroic or energetic will succeed without right direction—and such direction demands the full use of science.

Detailed information is lacking owing to irregularity in the mail system, but there are indications that many of the criticisms of Government policy have borne fruit. Scientific spirit, it seems, is slowly coming into its own in the conduct of the war. A remarkable instance is that of the Camouflage Organizations which were severely criticized by

Nature for not making sufficient use of scientific men and principles. In the last six months the Civil Defence Camouflage Organisation has gone far in utilizing scientific knowledge and scientific methods.

Several vitamin committees have been appointed for mass manufacture of vitamins and their addition to available food during apprehended periods of food crisis. Prof. F. A. Lindemann, to whose researches the excellence of Britain's Air Armada owes much, has been appointed personal adviser to the Premier in scientific matters.

Most significant however is the recent appointment of a Scientific Advisory Committee* consisting of six members, all of whom are fellows of Royal Society. Three of the members, the secretaries of the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council are already in public service, and the other three are the president and secretaries of Royal Society. In the appointment of the above committee there is a recognition of the principle advocated by the president of the Royal Society, Sir William Bragg (see SCIENCE AND CULTURE, Vol. 6, pp. 191-193, 1940-41) that science should have a hand in formulating policy and in other ways exerting a direct and sufficient influence on the course of Government. The Scientific Advisory Committee will really do a vital service if it can make its voice heard in the deliberations of the various ministries.

We have given a rather detailed review of some of the most important points stressed by the twenty-five British scientists, because in many of their findings against the Government, the civil service, and the vested interests, our readers will recognise the views voiced by SCIENCE AND CULTURE regarding similar situations in this country long before the outbreak of the present war. But while under the stress of the war and under the dynamic leadership of the present British premier, England has been quick to readjust her political machinery to, at least, the partial satisfaction of her scientists, this country continues to suffer from a mental black-out which is gradually becoming impossible to tolerate. If timely lesson be not learnt from what Great Britain has been doing, the consequences may drift to be disastrous to this country.

* See Notes and News section of this issue under the subheading—Report of the Royal Society, on page 513.

The White Sandal

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IS white sandal (*Santalum album*) indigenous to India? This question has for some time engaged the attention of the authorities of the Kew Garden and no fewer than four papers¹ have already been contributed in this connection. In the last contribution Mr Fischer has quoted and discussed a considerable mass of evidence for and against the Indian origin of white sandal, and has come to the conclusion, as was suggested in all his earlier communications, that white sandal is exotic in India and was introduced by "some enlightened person" from the Timor island sometime in the sixteenth century A.D. Those who are interested in the subject may profit by reading Mr Fischer's last paper both for references and arguments. While in England the present writer corresponded with him on this subject and Mr Fischer was kind enough to tell him that he was still open to conviction.

EVIDENCE IN LITERATURE

Mr Fischer has rejected as dubious the few references in Indian literature, which mention white sandal to be a "natural growing" plant in this country. He has relied for his conclusions mainly on the testimony of four modern authors, viz., Barbosa (c. 1500 A.D.), Garcia da Orta (1562 A.D.), Abul Fazl (1551—1602 A.D.) and Buchanon (1780—1800 A.D.); and has stressed the peculiar geographical distribution of the species.

Barbosa, who served chiefly in the Malabar coast, does not mention sandal tree as growing in India; on the other hand, he asserts that the plant grows nowhere but in Timor; he even excluded sandal from the list of articles exported from Cochin or

Calicut.² But we have the epigraphical evidence that the Kākatīyā sovereign, Ganapati Deva Mahārāja (1199-1260 A.D.) levied *kūpaśulka* on cargo of sandal wood shipped by the merchants of the seaport Moṭṭupalli (modern Mutfli), and a century later another sovereign of the same dynasty, Annapota Reddy, granted a charter to the seamen's guild of the same seaport in which he remitted one third of the export duty on sandal wood³.

Garcia da Orta writes: "The Malayalims also say that they have a scented wood which is like white sandal . . . They called it Sambarane" (Fischer, p. 462, 1938). From this statement Mr Fischer concludes that "Garcia da Orta positively stated that it (sandal tree) did not grow in India" (p. 464). At another place the same author writes: "I would have you also to know that the sandal tree is found in other parts; I saw it in Amdanaga (Ahmednagar) where it was brought to be sown. . . I saw there at a pleasure house . . . trees of sandal wood" (Fischer, p. 463). From this, Mr. Fischer considers that the plant was introduced into India (p. 464).

Abul Fazl⁴ writes, "Sandal wood is called in Hindi *chandān*. The tree grows in China. During the present reign it has been successfully planted in India" (Fischer, p. 463). It is difficult to conclude anything from this statement of Abul Fazl. It may be said that sandal is not a natural product of Northern India. Perhaps the supply during Akbar's reign came via some seaport in Bengal. It is never denied that a part of the sandal wood might have been brought by way of exchange by the Indian merchants from the Far Eastern countries with which they had trade. This might have been

¹ T. A. Sprague & V. S. Summerhayes, *Kew Bulletin*, pp. 193, 200-202, 1927. C. E. C. Fischer, *Jour. Ind. Bot. Soc.*, VII, 12-13, 1927. C. E. C. Fischer, *Kew Bull.*, pp. 185-195, 1935. C. E. C. Fischer, *Jour. Bombay Natur. Hist. Soc.*, XL, pp. 458-466, 1938.

² *loc. cit.*, The Coast of East Africa and Malabar, *Hakluyt Soc.*, 35, cited by Fischer, p. 463 (1938).

³ *Madras Ept., Inscriptions* Nos. 600, 601 of 1906; see R. K. Mukherji's *Local Govt. in Ancient India*, 1919.

⁴ *Ain-i-Akbari*, I, Ain. 30; 9, Blochmann & Jarret ed.

responsible for the statement of Abul Fazl which appears to be loose.

Buchanan did not find extensive cultivation of sandal trees during his journey from Madras through Mysore, Canara and Malabar. The explanation why he failed to see its extensive cultivation has been supplied by Mr Fischer himself. Even in Tipoo Sultan's time the tree was known as the royal tree. It was the property of the rulers and by private persons the tree was regarded as an unwarranted possession. We find the same thing even at the present time with regard to hemp. This is a native of Bengal, but is cultivated only in a small subdivisional town of Rajshahi as a government monopoly. It is a crime to cultivate a single plant on one's homestead land.

GEOGRAPHICAL DISTRIBUTION

The present geographical distribution of sandal and allied species is mainly eastward from Timor and adjacent islands. From Timor to South India is a gap of more than 2500 miles. Without the 'theory of introduction', Mr Fischer thinks, the absence of sandal trees between these two outposts, appears inexplicable. But what is there to disprove the theory of diphyletic origin of sandal simultaneously both in Timor and India?—a possibility justified by the present distribution of the allied genus *Mida*, one species of which grows in New Zealand and the second in the island of Juan Fernandez, a distance of nearly double of 2500 miles. Prof. Seward in his presidential address to the Geological Society of London (1924) suggested on palaeontological evidence that spontaneous origin of new and independent lines of evolution in different parts of the globe was not only possible but quite probable.

FURTHER EVIDENCES FROM ANCIENT SOURCES

It is admitted (Fischer p. 459) that *chandana* was known and used in ancient India long before the Christian era as a drug and as an article of toilet (cf. the *Jatakas*, *Arthashastra*, medical treatises, etc.) but there is nothing to contend that the wood was not or could not have been imported from Timor into this country. But where is the clear evidence, Mr Fischer asks, that this plant was cultivated or existed as a natural growing tree in ancient India?

Having considered the main evidence put forward by Mr Fischer against the Indian origin of sandal, let us quote and discuss some additional evidence which Mr Fischer has failed to take into consideration.

In the *Sino-Iranica*⁵ it is written that in the *T'ang Annals* (not later than 8th or 9th century A.D., may be 6th) it is mentioned that India exported sandal wood to Camboja and the anterior Orient (not far from the Timor island).

Chau-Ju-Kua⁶ in his work *Chu-fau-chi* on the Chinese and Arab trade in the 12th and 13th century A.D. records that the sandal wood is the product of T'ien Chu (western coast of India).

Mathioli⁷ writes in 1554 A.D. that sandal grows in East and West India (S. India) in large thick forests. There are three kinds: the best has pale yellow colour, white is next but the red is worst (see *Amarakosha*, infra).

Iassen⁸ while not denying that sandal grows endemic in Timor island, writes that the best variety (geschät ztbeste) grows in Malabar.

The Portuguese Governor at Goa in his letter dated 22nd July, 1764, to the Home Authorities wrote: "For centuries together since the discovery of India (1498 A.D.) this realm (Kanara) supplied Asia with all its rice, Europe with a large quantity of pepper and *China with sandal*, which commodities these dominions produce in abundance"⁹.

The philological evidence is worth considering here. In all countries west of India sandal is known by its Indian name, *chandana*. In the countries east of India sandal is known as follows¹⁰:—

Java—chandana, chandani.

Sumatra—chandana.

Siam—chantana.

China—chitan.

Sundanese (Lesser Sunda)—islands and eastward up to Celebes—chandana.

Malay—chëdan, but this term is also applied to *Eucarya*.

⁵ Ed. B. Laufer, p. 318, Chicago, 1919.

⁶ Eng. transl., Friedrich Hirth & W. W. Rock Hill, p. 209, St. Petersburg, 1911.

⁷ Hobson-Jobson, p. 790, London, 1903.

⁸ loc. cit., *Indische Alt.*, I, pp. 336-337.

⁹ Dr S. N. Sen, *Calcutta Review*, p. 259, Dec. 1937.

¹⁰ *Dic. Econ. Products of India*, VI, p. 461. *Dic. Econ. Products of Malay Penin.*, II (1-2), p. 1955-1956 (1935).

It is difficult to say if *chandana* is a Sanskrit or a Dravidian word, but the author has found the use of the term *chandana* for white sandal in the *Vinaya Piṭaka* (4th or 3rd century B.C.) and in the *Patañjali Mahābhāṣya* (1st century B.C.)¹¹.

The incident mentioned in the *Vinaya Piṭaka* was sculptured on the Bhārut railings¹² in the later half of the 2nd century B.C. In this the dedication of Jetavana has been depicted with three (out of four) sandal trees and a mango tree that are left behind after the clearance of the site by the purchaser, Anāthapiṇḍika, the banker. This may be accepted as a concrete instance to show that sandal trees grew in India.

The literary evidence regarding the presence of sandal trees in India has already been dealt with and dismissed by Mr Fischer as dubious. But some of them are worth repeating here. The *Ramayana* refers to the river Tamraparni with its islands as covered with fair forest of sandal. Kalidasa in the *Raghuvamśa* (IV, 51) mentions the two mountains Malaya and Dardura, as having sandal forests on their peaks. According to the *Pāñchatantra* the sandal does not flourish anywhere else except in the Malayas (I, 42). These are only some of the positive statements quoted by Mr Fischer himself (p. 460).

In the *Amarakosha* (Lexicon, 3rd or 4th century A.D.) it is said "*vinā-malayam-anyaṭra candanam na vivardhaté*". This is exactly what has been corroborated in the *Pāñchatantra*. Cunningham¹³ located Malaya in the seacoast of South India.

At another place of the same lexicon it is said with regard to sandal—*malayottham pīlakāshṭham*, i.e., the Malaya-born is yellow (creamy)-wooded, and described as the best variety. The fact that the Indian variety is the best has been substantiated by Mathioli, Lassen and in the *Dictionary of Economic Products of the Malaya Peninsula* where it is said, "It is interesting that Indian sandal wood is richer in oil than Malaysian and Timor sandal wood" [pp. 1952-1956 (1935)].

The 50 odes that had been composed addressing this plant before the 14th century A.D. could not

have been written without any acquaintance with the tree itself and its habitat¹⁴.

Curiously enough *chandana* is not mentioned in the Vedic texts composed in the Land of the Five Rivers and the so-called Madhyades (Midland). This fact tends to confirm the South Indian origin of this plant.

According to Mr Fischer the ancient Indians used the term *chandana* to denote some scented wood or woods (p. 465) other than sandal proper. This conclusion seems to be far-fetched. The ancient medical treatises like those by Charaka and Suśruta distinguished at least three kinds of sandal, viz., white sandal (*Santalum album*), called *śveta-chandana*; red sandal (*Pterocarpus santalinus*), called *rakta-chandana*; and an inferior sandal (*Adenanthera pavonia*), called *ku-chandana*. These were different plants belonging to different species and families, and their properties were also different as will be evident from their synonyms:

1. *Sveta-chandana*—Syn. *Malayaja* (Malaya born), *gandharaja*, *gandhasāra*, *sarpāvāsa*, etc.
2. *Rakta-chandana*—Syn. *Pravāla-phalam* (coral-red seeded), *tāmrasāra*, etc.
3. *Ku-chandana*—Syn. *Paṭṭa-rañjanam* (linen dyer), *rakta-kāshṭha*, etc.

Could we still think that the ancient Indians confused between the different kinds of *chandana*? The ancient medical treatises, e.g., the Charaka and Suśruta *Saṁhitās* even distinguished a few varieties of *śveta-chandana* on the basis of their habitats. Thus *Bhadraśrī* and *Malayaja* grew on the Malaya mountain; *Varvara* and *Gośṛṣa* on the mountains of the same name, while *Betal* and *Sukkaḍ* on two adjacent ranges of the same name¹⁵.

CONCLUSION

Bengal had direct maritime intercourse with the Far Eastern countries. It is not at all unlikely that on their homeward journey the ships did bring some amount of sandal wood from those places, as it was a very valuable commodity. And it was from Bengal that Delhi got her supply. Abul Fazl might have been led to his notion of the Chinese origin of

¹¹ *loc. cit.*, Vol. I, Kielhorn ed., p. 413 (1880), 2.2.8.2, 3.

¹² Dr. B. M. Barua, Bharut, Aspects of Life and Arts, Vol. III, Plate XLV, fig. 46 (1937).

¹³ *loc. cit.*, The Ancient Geography of India, pp. 628-629.

¹⁴ Majumdar, *Upavana Vinoda*, Calcutta, 1935.

¹⁵ See also *Jour. Asiatique*, XI (1918), Pour L'Histoire Du Rāmāyaṇa par M. Sylvain Lévi, pp. 104-111, in connection with *Gośṛṣa* growing on the Malaya mountain.

sandal from this fact. Dr Watt however is definite that sandal is not a native of China. He says "the mistake of the Chinese origin of sandal has arisen from the fact that Chinese vessels at the time of *Cosmos Indicopleustos* (6th century A.D.) made the voyage between China and the Persian Gulf, stopping to trade in Ceylon and India, and disposing of their cargoes finally to Bagdad merchants"¹⁸.

In conclusion we may summarise the following facts.

1. China and the Far East used to import at least a part of the sandal wood from India even up to about the 8th or 9th century A.D.

¹⁸ *loc cit.*, Commercial Products of India, p. 976.

2. Best variety of sandal grows in India.
3. It was a 'royal tree', people had no right to its cultivation.
4. Indian term *chandana* for sandal is used in the Far East islands and countries.
5. Literary and other evidences, Indian and foreign, of periods earlier than the 13th or 14th century A.D. point to its presence as a natural growing plant in India.
6. The three sandal trees along with a mango tree sculptured on the Railings of Bhārut is a positive proof of its growing in India, at least in the second century B.C.

FACTORS FOR COUNTRY'S DEVELOPMENT

Agriculture is a necessary occupation. But no agricultural nation has become rich. Nations which wanted to improve their position have always turned to industries and commerce for betterment. The United States of America, Japan, Russia, Sweden and Canada are instances in point. Food and raw materials being essential to a nation, their production should be not on the primitive lines on which we are going on but should be industrialised. The bulk of the population should be employed on industries, trade, transport and other profitable occupations. The American view of life is that "those who do not work shall not eat". The income in the United States of America is high because they work harder, their knowledge, both general and technical, is better and they work on a system devised by Government. Their Government looks after the economic safety and needs of the people. An American writer, Lewis I. Lorwin, writing in *Plan Age* in February 1935, says:

"Of the 49 million people in the United States who today carry on the work of the country, at least 35 million are regimented in detail for at least 8 hours of each working day".

In contrast to this, we have in this country an enormous rural population, who have no steady occupation for four to six months in the year.

The reason why people in advanced countries enjoy a higher income is that they use their energy and time on the most profitable pursuits. While only one-tenth of our population can read and write, almost the entire population of civilized countries is educated. They, therefore, know that it is to their advantage to work harder, more systematically and under better organisation and discipline and to produce by all these means goods and services of vastly higher value than we in India are able to do. If our people here also work similarly, if they increase their hours of labour, improve their skill, workmanship, organisation, discipline and teamwork, this country too will be able to produce goods and services of far higher value than it is able to do at present. Such necessary changes in habits and practices, if brought about will automatically lead to a higher standard of living. Disciplining a nation is possible under a well-organised Government. It might at first sight seem difficult but in the permanent interests of the country it should be persevered in.

—From an address by Sir M. Visvesvaraya at the Mysore Chamber of Commerce.

How Big is the Moon and How Far is the Sky*

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IT is a matter of common observation that the Sun, the Moon and constellations appear much bigger when near the horizon than when they are high up in the sky.† The Sun and the Moon when high up appear (to most people) a little less than a foot in diameter, and near the horizon they look from 2 to 3 times bigger—the effect is greater in twilight and when the sky is clouded. It is needless to add that the entire phenomenon is psychological, for there is no physical reason why we should associate a linear size of one foot with an angle of about half a degree—the angle subtended by the Sun's diameter is $31' 59''$ and the mean angle** for the Moon's diameter is $31' 5''$, and why the size should appear to vary with altitude though the angle subtended at the eye and hence the size of the retinal image remains constant.

The apparent variation of size with altitude exists also in the after-image of the Sun (and also the Moon) which is obtained by viewing the Sun for an instant and then blinking. The after-image of the Sun at the horizon when projected upon the sky at horizon as background appears to be of the same size as the Sun, but is reduced to about half its size when projected on the sky near the zenith. If instead of projecting on the sky the

after-image of the Sun when at horizon, we project it on a wall, then it appears smaller than the Sun if the distance of the wall is less than about 200 feet, but on a wall at about 200 feet or beyond the size appears to be the same as that of the Sun. This shows that the distance of the horizon-sky appears to be about 200 feet, and of the sky at zenith about half of this.††

There seems to be a possible connection between the apparent variation of the size of heavenly bodies with the altitude and the apparent flattening of the vault of heaven. When we look at the sky, the impression that we get is not that of an inverted hemisphere with ourselves at its centre, but it appears like a flattened dome whose distance from eye to zenith is smaller than the distance from eye to horizon, the ratio being from 2 to 4 depending on the observer and the circumstances attending the observation. The apparent flattening of the sky is felt vividly when we try to locate the mid-point of the arc joining the zenith and the horizon.

If we point our hand or a stick in the direction of the mid-point, and if then the angle be measured, it is found that the altitude of the estimated mid-point M is much lower than 45° . It generally lies between 20° and 30° (Fig. 1). In these and other psychological observations it is necessary that the observer should allow himself to get the impression as he sees it or feels it, and not modify it by making a conscious effort in trying to see what he (according to his preconceived ideas or theoretical knowledge) ought to have seen. We are observing an illusion and the observation is vitiated to the extent that we make any conscious effort to overcome it. Scientific

* A very interesting article by Professor H. N. Russell has recently appeared (*Scientific American*, Oct., 1940) on the subject of apparent variation in the size of the Moon. Also see Hargreaves, *Observatory*, June, 1940.

† The apparent variation of size persists even when the bodies are seen through a telescope.

** When the Moon is at the horizon its distance from the observer is greater by the earth's radius than when it is at the observer's zenith, and therefore the angular diameter, at the horizon compared to that at the zenith is actually smaller by $0.5'$. The variation in the distance of the Moon from the earth due to the eccentricity of its orbit introduces in the angular diameter a variation of over 10 per cent.

†† 200 feet is a little less than one third the radius of stereoscopic vision calculated on the basis of one minute as the resolving power of the eye.

observation and study of illusions require psychological training.

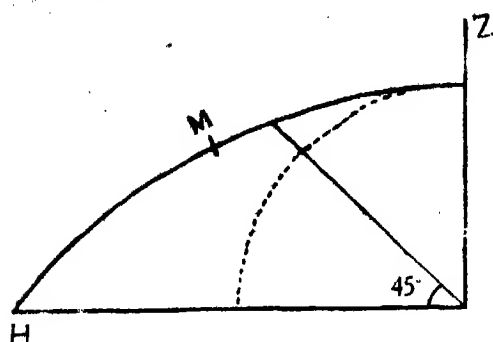


FIG. 1. H is the horizon and Z is the zenith. M is the mid-point of the arc of the sky HZ.

Robert Smith¹ (*Optics*, 1738) suggested more than two centuries ago that we imagine the Moon, the Sun and the stars to be at the same distance as the sky, and therefore they appear to be several times more distant when at the horizon than at zenith; and as the angle subtended by them at the observer's eye remains the same, greater distance is associated with a proportionate increased (linear) size. In support of this view it may be noted that in twilight or when it is cloudy the sky looks more flattened and therefore at the horizon farther away than ordinarily, and the Sun or the Moon at the horizon also appear larger. But why does the sky appear flattened? Let us first take up an interesting explanation due to Sterneck², which, however, as will appear later has to be discarded.

Sterneck gave an empirical relation between the true distance and the apparent distance of an object, and he was able to connect in this way a large number of phenomena, e.g., street-lamps farther away than about 150 yards seem at night to be all at the same distance; rectangular fields seen from a train appear trapezia; the steepness of a mountain-slope is over-estimated when seen from the bottom of the mountain and under-estimated when we stand at the top; and the flattening of the celestial vault. Van Sterneck's formula is

$$x' = \frac{cx}{c+x} \quad (1)$$

where x is the true distance, x' the apparent distance and c is a constant. The apparent distance is

always smaller than the true distance, and c is the limit which it approaches for increasing true distance. The value of c ranges from about 100 yards to 10 miles depending upon the nature of the object whose distance is estimated and on the circumstances under which it is observed.

When the sky is clouded, the clouds, being at an extremely small height compared to the earth's radius, form a practically flat ceiling above us.* The distance r between the observer and the cloud in the direction θ from the vertical is $p \sec \theta$, p being the vertical height of the cloud, and therefore if δ denotes the ratio of the apparent distance in the direction θ to the apparent vertical height of the cloud, then from equation (1), δ will be given by

$$\delta = \frac{1 + \frac{c}{p}}{1 + \frac{c \cos \theta}{p}} = \frac{\delta_0}{1 + (\delta_0 - 1) \cos \theta}, \quad (2)$$

where δ_0 is the ratio of the apparent horizon-distance to zenith-distance. The cloudy sky should therefore appear like a hyperboloid of revolution (with the observer at its focus), which does agree with our general impression of it.

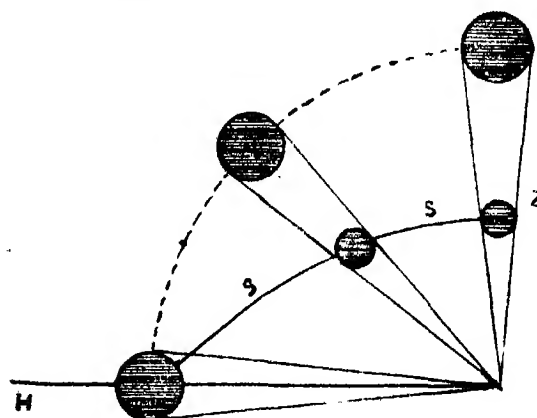


FIG. 2. H is the horizon. Z is the zenith. S S represents the sky. The figure illustrates Robert Smith's explanation of the apparent variation in the size of the Sun (or the Moon) due to the apparent flattening of the sky.

However, not only a cloudy sky, but a blue and a starry sky also give the same impression of being flattened—only the flattening is less,—and it is difficult to see how Van Sterneck's explanation could be applied to a featureless blue sky. But a

¹ M. Luckiesh, *Visual Illusions*, D. Van Nostrand Co., New York, (1922). Chapter XI.

² M. Minnaert, *Light and Colour in the Open Air*, Bell and Sons, London, (1940). Chapter IX. This is one of the best books on "everyday physics" that the writer has come across.

* If the cloud be at a vertical height of one mile, then, even for an altitude of 10° , the distance of the cloud, assuming the cloud-bank to be a flat ceiling, will exceed the distance calculated on the assumption that the cloud-bank is a concentric sphere round the earth by less than 0.5 per cent.

serious objection to this explanation is the fact that the apparent shape of the sky is dependent on the way the observer holds his body during the observation. If instead of standing, the observer lies flat on his back on the ground, the appearance of the sky is completely altered—it is spherical towards his feet but compressed towards his head. The flattening of the sky is relative to the observer's "personal horizon" which is a great circle perpendicular to his backbone. When the head is held in its normal position relative to the body, the observer's gaze is

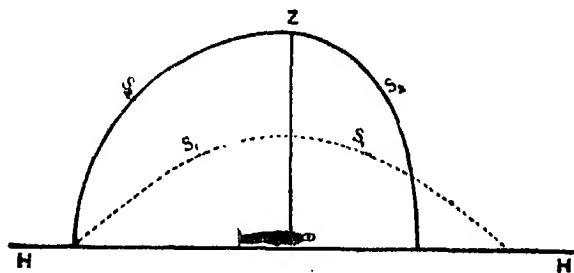


FIG. 3. H is the horizon and Z is the zenith. S_1, S_1 is the apparent shape of the sky when the observer is standing. S_2, S_2 is the apparent shape of the sky when the observer is lying on his back.

towards his personal horizon. The head has to be thrown backwards to see the sky above the personal horizon, and bent forward to see below it. The sky below the personal horizon appears spherical and flattened above it. In fact, if an observer supports himself from a horizontal bar with the body vertical and head downwards, the whole sky is below his personal horizon and appears to him spherical.³

It is not only the flattening of the sky which is related to the personal horizon, but the apparent variation in the size of heavenly bodies is also dependent on it. This has been conclusively established by Professor Boring⁴ (and his colleagues) at Harvard, who recently reported his results to the United States National Academy of Sciences. The Moon looks big when it is near the observer's personal horizon. It appears smaller when it is away from the personal horizon, it being immaterial whether it is above or below it—the phenomenon is symmetrical with respect to the personal horizon. Further,

the Harvard psychologists find that the Moon, even when high in the sky, produces the impression of looking (to an observer standing on the ground) as big as a disk about 5 inches in diameter placed 10 or 12 feet away—the apparent angular diameter is about four times its real value. At the horizon the Moon appears twice as big. The apparent magnification of the angular diameter is significant: our estimates of the size and distance are not conditioned by the actual visual angle.

The question remains: why the Moon looks largest when it is at the personal horizon? Why there is an association between the apparent size of the Moon and the bending of the head (backwards or forwards depending on whether the Moon is above or below the personal horizon) necessary to look at it? A possible explanation⁵ is to be sought in our everyday experience. When an object approaches us we have in most circumstances to bend our head to see it,—forwards if the object is on the ground, and backwards if it is a flying bird or a cloud. The angle subtended by the object increases with increasing bending of the head, but, provided the object was approaching us from not too large a distance, our training in interpreting visual perceptions has been such that the impression of its size remains almost the same: it is nearly its true size. It seems that we assign unvarying size not by making allowance for the varying distance, but on the contrary we carry as it were the 'size' in us (—'we are geometers by nature'—) and judge of distance from the visual angle through its (size) help. We get so much accustomed from common experience to a large visual angle when the object is seen with the head in its normal position and to a small visual angle when the same object is seen with a bent head—the impression of size being the same in the two cases—that for the Moon, as the angle remains the same, we get an impression of a smaller size when we have to bend our head in order to see it.

The apparent shape of the sky can also be explained on similar lines by assuming that our daily experience accustoms us to a relation between distance of objects and the bending of the head necessary to see them, but it must be admitted that these are only plausible suggestions and at present no explanation of the apparent variation in the size

³ M. Minnaert, *loc. cit.*, p. 163. Fig. 3 is also taken from this book.

⁴ H. N. Russell, *loc. cit.*

⁵ This has been suggested by Professor Russell; *loc. cit.* See also Minnaert, p. 162.

of heavenly bodies or the shape of the sky can be regarded as reasonably satisfactorily established.*

We have mentioned that if the distance of an object is not too large, the impression of its size is independent of the distance. When the distance is large, the apparent size decreases, and it appears very likely that the relation between apparent size and real size is of the same form as Sterneck's formula for apparent distance, i.e.,

$$\left. \begin{aligned} y' &= \frac{yc'}{c' + x}, \\ \text{or } y &= y' + \frac{y'}{c'} x, \end{aligned} \right\} \quad (3)$$

where y' is the apparent size of an object of true size y and at a distance x , c' is a constant, its particular value depending on the circumstances under which the object is observed and is probably different from value in the distance-formula (1). The apparent size is half the true size for $x = c'$. So long as x is small compared to c' , the apparent size does not vary appreciably, it is almost the same as the true size. For x large compared to c' , the apparent size is inversely proportional to x . Two straight lines, (telegraph wires, long stretched strings, straight edges of a foot-path etc.) will appear parallel when they are not *actually* parallel, but the distance between them increases linearly with x so as to

* It seems that a forward bending of the head has no effect on our estimate of distance, but bending the head backwards produces a bias in favour of underestimating the distance. The value of c in Sterneck's formula is unaffected in the former case, but reduced in the latter case.

satisfy (3). Relation (3) should hold fairly accurately for terrestrial objects.

When we look at an object through a telescope or binoculars, the visual angle subtended at the eye is increased by a factor which is the magnifying power (m) of the instrument. The effect is the same as if the true distance of the object had been reduced m times, and the apparent size of the object as seen through the telescope will be

$$y' = \frac{yc'}{c' + x/m} = \frac{m yc'}{mc' + x}, \quad (4)$$

For x small compared to $c'm$, the apparent size will be almost the same as the true size. This seems to agree with our (qualitative) experience and a detailed investigation will be interesting.

It may be remarked that our judgment of speed, say, when we are sitting in a car, is also modified because of the under-estimation of distance. If we judge the speed by looking at an object at a distance x from us, then the true speed ($\frac{dx}{dt}$) and the apparent speed ($\frac{dx'}{dt}$) are connected by the relation

$$\frac{dx'}{dt} = \left(\frac{c}{c+x} \right)^2 \frac{dx}{dt},$$

and if we are looking through binoculars, it becomes

$$\frac{dx'}{dt} = \frac{1}{m} \left(\frac{mc}{mc+x} \right)^2 \frac{dx}{dt}$$

or for x small compared to mc , the apparent speed is $1/m$ th of the true speed.

Dr H. J. Bhabha's Lectures on Cosmic Radiation

ON the invitation of the University of Calcutta, Dr Homi J. Bhabha of Bombay delivered a series of ten lectures in the Calcutta University during December, 1940. It covered a wide field of cosmic ray and nuclear physics, dealing with such subjects as Störmer's theory of the paths of electrons in the earth's magnetic field and its application to cosmic radiation by Lemaitre and Vallarta; an account of the theories of cascade showers and ionisation showers which were first successfully developed by Dr Bhabha himself in a series of papers communicated to the Royal Society; and an account of the theory of fundamental particles, in which Dr Bhabha has made notable contributions to the theory of mesons, formerly misnamed heavy electrons. The lectures were largely attended and stimulated wide interest in the circle of physicists and mathematicians in Calcutta. It may be mentioned in this connection that Dr Bhabha has predicted two new particles, a proton with a negative charge and a proton with a double positive charge. According to his prediction, the masses of these particles are slightly greater than that of ordinary protons and hence one should expect them to be produced in the laboratory more frequently when substances containing hydrogen are bombarded by protons having an energy exceeding some 35 million electron volts. At present particles of such high energy can be obtained only in the 60-inch cyclotron of the University of California.

But nature has provided us with more energetic particles in cosmic rays, their energies ranging from as much as 100 million to a million million electron volts and more. Dr Bhabha has been directing Mr P. C. Bhattacharyya, a research scholar of the Palit Laboratory in the University College of Science, Calcutta, in a search for his predicted particle in the photographs of cosmic ray particles which have already been published by leading English and American workers. In the light of Dr Bhabha's prediction, the previous identification of the tracks has to be reconsidered. Two tracks have been suspected to be those of double protons, but new and more thorough experiments are necessary before

any claim can be established. Dr Bhabha is considering instituting these experiments in India.

We are giving below a short life sketch of this young Indian scientist, whose reputation is a matter of pride to us.

DR HOMI J. BHABHA was born on October 30, 1909, at Bombay and comes from a well-known Parsi family. His grandfather, Dr H. J. Bhabha (senior), C.I.E., was director of public instruction in the Mysore State for about twenty years and his father, Mr J. H. Bhabha, is one of the Tata representatives on the Council of the Indian Institute of Science, Bangalore.



DR HOMI J. BHABHA

After a brilliant career in Bombay, Bhabha was sent to Cambridge at the early age of 17 where he joined Gonville and Caius College. He took the

mathematics tripos, part I, at the end of his first year and then branched over to engineering, taking the mechanical sciences (engineering) tripos, part II, in 1930 with a first class. In the long vacation of the year 1929 he worked for some months as an engineering apprentice in the British Thompson Houston Works at Rugby.

After graduation (1930) Dr Bhabha decided to take up mathematical physics seriously, a subject which had fascinated him from his school days. He studied modern theoretical physics under Professors P. A. M. Dirac and N. F. Mott for two years. Up to this time, he had held several college scholarships and studentships.

In 1932 he was awarded the Rouse Ball travelling studentship in mathematics from Trinity College and spent 1932-33 at Zürich working under the famous Professor W. Pauli, when he wrote his first paper "Zur Absorption der Höhenstrahlung" at the end of that period. In 1933-34 he worked with Professor E. Fermi at Rome and Professor H. A. Kramers at Utrecht and in 1936-37 spent five months at Professor Niels Bohr's Institute of Theoretical Physics at Copenhagen.

He had already been awarded the Isaac Newton studentship in 1935 for three years, and in 1937 he was awarded the senior studentship for Great Britain of the Exhibition of 1851, which he held for three years. He is the only Indian to have had this distinction.

From 1935 until 1939 when the outbreak of war prevented his return to England, Dr Bhabha has been lecturing at Cambridge on cosmic radiation, nuclear physics and relativistic quantum mechanics (besides giving the usual elementary courses on electricity and magnetism). In October, 1937, at the invitation of Professor Max Born he gave a course of lectures on cosmic radiation at Edinburgh.

In 1939 the Royal Society decided to finance him out of the Mound Fund to act as theoretical physicist to Prof. Blackett's school of cosmic ray research at Manchester, and to enable him to carry on his own work at Manchester and Cambridge. He was also invited to attend the Solvay Conference at Brussels which was to have been held in the October of 1939, but the outbreak of war prevented its meeting.

He came out frequently during the summer vacations to India and it was while on one of these holidays that the war broke out and made his return to England unnecessary. Since then he has carried on his own research at the Indian Institute of Science, Bangalore.

It will be seen from the above short account, that Dr Bhabha has had the privilege of coming into contact with the best brains in theoretical physics, and has made contributions of outstanding merit to cosmic ray physics. As readers of SCIENCE AND CULTURE are aware from several articles published in our columns, cosmic ray investigations have proved extremely exciting in recent years. For getting further knowledge of this phenomenon, scientists have travelled all over the globe from almost the North Pole to the South, and have sent their measuring instruments from the deepest accessible depths in mines and lakes to a height of 28 kilometres which is practically the top of the atmosphere. In Dr Bhabha India is now in the fortunate position of having one of the foremost successful interpreters of this exciting phenomenon; she has also a fine batch of workers at Bangalore, Calcutta (at the Bose Research Institute, and the University College of Science), and Lahore (P. S. Gill). It would be quite feasible to have a cosmic ray research scheme in which all these workers could undertake co-operative research as in the U. S. A., under the guidance of Dr Bhabha.

We hope later to publish a more detailed account of Dr Bhabha's lectures.

Temperature of the Upper Atmosphere

A. C. DEB

Wireless Laboratory, University College of Science, Calcutta.

THE distribution of temperature in the atmosphere up to a few tens of kilometres above the surface of the earth is well known from direct meteorological observations. In the tropospheric regions up to 12 to 15 km. the temperature decreases linearly with height. It then remains fairly constant in the stratosphere up to about 35 km. which is the height attained by average sounding balloons. The temperature distribution beyond this height can only be inferred indirectly. For instance, from the undoubted presence of ozone in the region 30-55 km., as also from the phenomenon of the anomalous propagation of sound waves, it is



FIG. 1. Luminous night clouds: Photograph by Störmer taken at Lillehammer (Norway) on the 24th July 1937; height of the clouds above the surface of the earth is 81 km. The clouds are made visible by being illuminated by the rays of the sun from below the horizon and are believed to consist of ice crystals. The temperature of the atmosphere in the region near the clouds must therefore be low.

inferred that the temperature at 55 km. level is of the order of 370°K . Again from the value of the so-called "scale-height" H in an ionised region measured by radio method¹—reference to which will

presently be made—it is estimated that a low temperature, about 200°K , prevails at 70 km. level. Low temperature round this region is further confirmed by the occurrence of noctilucent clouds² in a narrow range of height about 80 km. These clouds, consisting of ice crystals, are often seen in northern countries, by being illuminated by oblique rays of the sun from below the horizon. It is estimated that the temperature here is of the order of 160°K . (Fig. 1). For the region round 100 km., radio measurements again furnish data, not only in regard to temperature—from the scale height measurements as mentioned above—but also regarding molecular density. The accepted values of temperature and molecular densities at this level are 300°K . and 3×10^{13} mol./c.c. respectively. For the region above 100 km., i.e., for the upper atmosphere proper, data are again available from a number of atmospheric phenomena from which it is concluded that a temperature of 1000° to 2000°K . prevails in the upper reaches of this region. (See Fig. 4).

In the present paper will be discussed, in particular, the various evidences which point to the existence of a gradient of rising temperature in the last named region of the atmosphere. These evidences are:

1. Extension of auroral rays to great heights.
2. Escape of helium from terrestrial atmosphere.
3. Width of the green line ($\lambda 5577$) of the light from the night sky.
4. (a) Comparative thicknesses of the Regions E and F of the ionosphere.
(b) Absorption of radio waves in the Region F.

¹ Badden, Ratcliffe and Wilkes, *Proc. Roy. Soc. A.*, 171, 183, 1939.

² Störmer, *Beiträge Zur Physik der Freien Atmosphäre*, Bd. 21, Heft 1, 1933.

We may at the outset allay any misgivings regarding the applicability of the concept "temperature" to the high regions of the atmosphere under consideration. It is obvious that the temperature of a gas as defined by the gas kinetic relation $\bar{v} = \sqrt{\frac{8kT}{\pi m}}$ will have no meaning if the gas under consideration be so attenuated and, as a consequence, collisions between the molecules be so few and far between that average velocity \bar{v} ceases to have any significance. We cannot, for instance, ascribe any temperature to the inter-stellar space which, as is well known, is not entirely devoid of matter, but is estimated to contain about one particle per c.c. Collision between the particles in such a space is an extremely rare event and does not permit of any averaging out of the wide range of velocities of the particles. Now in any region above the surface of the earth, the atmosphere, in the ordinary sense of the term, can exist only if the molecules in the region concerned are prevented from escaping by collision with the molecules above. The atmosphere will cease to exist in the region where a molecule receiving impact from particles below does not return to the earth by collision with other particles above. They may, of course, do so by describing trajectories under the influence of gravity, but the regions where such trajectories lie will not belong to the atmosphere proper. They would belong rather to the "fringe" of the atmosphere and the concept of "temperature" will obviously have no meaning for such regions. For all the underlying regions, however, where there are frequent collisions preventing the molecules from escaping into the fringe region, temperature *will* have a meaning as defined by the above relation. The question whether a region above the surface of the earth has a temperature or not thus resolves itself into the question whether the region concerned has an atmosphere or not. The various geophysical phenomena which will presently be discussed indicate that the region three to four hundred kilometres above the surface of the earth does have an atmosphere in the ordinary sense of the term and as such has a temperature.

EXTENSION OF AURORAL RAYS TO GREAT HEIGHTS

Measurements have shown that while the lower limits of the aurorae of the ray type, occur most frequently at the height of 100 km., their upper

limits extend up to four to five hundred kilometres above the surface of the earth. (Fig. 2). Under special circumstances, when the rays are formed, for instance, in a sunlit portion of the high atmosphere, the upper limit is observed to extend even beyond 1000 km. These observations show that the atmosphere as such i.e., the atmosphere in which the particles obey the gas kinetic laws must exist up to at least four hundred kilometres in ordinary



FIG. 2. Aurora of the ray type: Photograph taken by Störmer from Askim (Norway). The lower limit is at 95 km. height and the upper limit vanishes at 500 to 600 km, showing that there must be appreciable atmosphere at these heights.

circumstances. The molecular density prevailing at this height of the atmosphere can easily be calculated if the density and temperature at some datum level, as also the distribution of the latter in the region above be known. The datum level may conveniently be taken the level 100 km. where, as mentioned above, the temperature and density are known to a fair degree of approximation from radio measurements. Now if a constant temperature of 300°K. (the same as that at the 100 km. level) be assumed to prevail in the region above 100 km., then the density at 400 km. is found to be only 3 molecules per c.c. which means that there is no atmosphere in this region in the ordinary sense of the term. In fact, the gas kinetic laws, on the assumption of the applicability of which this figure is arrived at, will cease to hold from a much lower level. If now a rising temperature of 4° per km. is assumed (which makes the temperature at 300 km., 1100°K.) then the density at 400 km. becomes 10⁷ molecules/c.c. This number is quite adequate for the gas kinetic laws and shows that atmosphere

as such can exist at that height. If account is taken of the fact that oxygen in the upper atmosphere exists mostly in the atomic state due to photo-dissociation of O_2 by $\lambda > 1760$, then the density and collisional frequency at 400 km. level are found to be 10^9 molecules/c.c. and 20 per sec. respectively, which again shows that there is sufficient atmosphere at this height and beyond³. It has been shown by some authors⁴ that the height above which the density becomes too small for the gas kinetic laws to be applicable, may be made to extend up to 800-900 km.—the height up to and beyond which auroral rays are found to extend—only if a rising temperature gradient of 4° per km. be assumed to exist above 100 km.

ESCAPE OF HELIUM

It is well known that helium in large quantities escape with the natural gases emanating from the crust of the earth in various parts of the world. It has been found, for instance, that the natural gases from the so-called helium belt of North America—extending from Texas through Oklahoma, South Eastern Kansas, Southern Illinois, Ohio, Pennsylvania to New York—contain up to 1.5% helium and the total quantity of helium escaping from this source amounts to 2×10^7 cu. m. per annum⁵. If it be assumed that helium has been escaping at this rate for the last million years—and there is no reason why this should not be so—the helium content of the atmosphere from the American fields alone would be about 2×10^{13} cu. m. If account be taken of the amounts that are being emanated from other such sources on the surface of the earth, as also the possible greater rate of emanation in previous geological epochs, then the present helium content of the atmosphere ought to be several orders higher than 2×10^{13} cu. m.

Now the partial pressure of helium on the surface of the earth is 4×10^{-6} times the normal pressure. From this it is easy to calculate that the total amount of helium present in the atmosphere is only about 5×10^{12} cubic metres. The amount is far short of the quantity which ought to have accumulated in course of the past geological epochs according to the estimation made above. It is therefore evident that there must be a steady leak of

helium to account for its scarcity in terrestrial atmosphere. The two obvious modes of disappearance of helium are its chemical combination with other atmospheric gases and its escape from the atmosphere of the earth. The first of these possibilities is ruled out because of the chemical inertness of the gas. Regarding the second, calculations by Jeans show that helium can escape from the earth by overcoming the gravitational pull, if the temperature of the escaping helium be greater than 1100°K . The possibility of such escape has recently been examined closely by Helge-Petersen⁶. It is shown that if the temperature of the higher regions of the atmosphere be such that a gas may evaporate from the high atmosphere, then, in the presence of a steady afflux from the surface of the earth, the density distribution of the escaping gas will be substantially changed. In fact, the density would decrease much more rapidly with increasing height than it would, if the gas were in static diffusion equilibrium. The existence of a high temperature of the order of 1200°K . in the high region of the atmosphere, would therefore explain the remarkable scarcity of helium in terrestrial atmosphere in spite of its steady emanation from the earth's crust. That helium is also scarce in the higher regions is evinced by the fact that neither the light from the night sky nor that of the aurora, which latter is due to violent excitation of the upper atmospheric gases by bombardment of charged particles show any line which may be ascribed to helium.

WIDTH OF THE AURORAL GREEN LINE OF LIGHT FROM THE NIGHT SKY

It is well known that the sky in a dark moonless night is not entirely dark, but is faintly luminous and glows with a feeble bluish green light. Part of the luminiscence (about 30%) is due to scattering of the lights of the stars by the atmospheric molecules; but a substantial part is due to actual luminiscence of the atmospheric gases. This light, known as the light from the night sky or the permanent aurora, has been extensively studied spectroscopically and is found to consist principally of green light of wavelength $\lambda 5577$ ascribed to a so-called forbidden transition of oxygen atom. The atoms of oxygen emitting the light are transported, by some yet obscure process, to what is called a

³ Mitra and Rakshit, *Ind. Jour. Phys.*, 22, 47, 1938.

⁴ Mitra and Banerjee, *Ind. Jour. Phys.*, 23, 107, 1939.

⁵ Moore, *Nature*, 111, 88, 1923.

⁶ Helge-Petersen, *Pub. Det Danske Meteorologiske Institut*, No. 6, 1928.

metastable state, having a life of about 0.5 sec. The metastable atom in course of its transition to the state of normal atom emits the green auroral line $\lambda 5577$ as also two other fainter lines in the red. The ultimate source of energy of the light is, of course, the sun. The incident solar energy is stored in the high atmosphere during day time, by some means—still ill understood—and part of it is emitted during night in this form.

The line $\lambda 5577$, on account of its prominence, has been closely studied by various workers. Babcock⁷ in particular has made interferometer measurements of its wavelength and has found that its width is of the order 0.35 Å. (Fig. 3). Now, as is well known, the principal cause of the widening

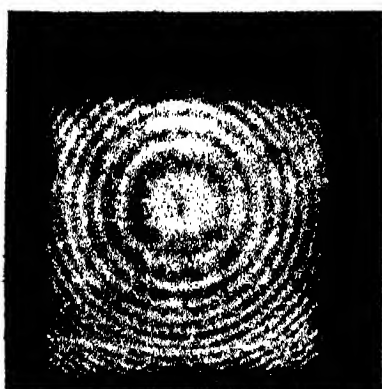


FIG. 3. Fabry-Perot interference pattern of the green light from the night sky (After Babcock). The width of the line is estimated from the distribution of light intensity in the interference pattern. The estimated width ($\Delta\lambda = 0.35\text{Å}$) shows that the emitting oxygen atoms of the atmosphere at a height of two to three hundred kilometres must have a temperature of about 1200°K.

of spectral lines is the Doppler effect due to thermal agitation of the light emitting particles—atoms or molecules—in the luminous gas. The spectral width $\Delta\lambda$ and the temperature T of the particles of the gas are related by the equation:

$$\Delta\lambda = 7.2 \times 10^{-7} \lambda \sqrt{\frac{T}{M}},$$

where λ is the mean wavelength of the line and M the weight of the emitting particles in terms of the atomic weight of hydrogen. Now, since the width of the 5577 line is 0.35 Å, the temperature

of the emitting oxygen atom, as deduced from the above formula, must be of the order of 1200°K. It may therefore be assumed that the temperature of the region from which the auroral green line is emitted—namely 200 to 300 km. above the surface of the earth⁸—is also of the same order. It should, however, be mentioned that it is possible to conceive of the temperature of the emitting particles as being different from that of the surrounding gas. In the absence of any evidence to the contrary however, inference regarding the existence of a high temperature as made above is not unjustified.

COMPARATIVE THICKNESSES OF THE REGIONS E AND F OF THE IONOSPHERE

It is now well established that the various ionised layers of the upper atmosphere are produced by the ionising action of the extreme ultra-violet rays of the sun. The formation characteristics of an ionised layer in an idealised atmosphere in isothermal equilibrium consisting of a single gas, has been worked out in detail by Chapman.⁹ It has been found that the thickness of the layer formed is approximately equal to $4H$, where H is the so-called "scale height" of the atmosphere in the region where the layer is formed.* Further, the height of the layer itself depends upon the absorption co-efficient of the photo-ionising solar rays. The greater the absorption co-efficient, the higher is the level of formation of the layer. Near the region of maximum ionisation, the density varies according to parabolic law.

It is obvious that if, instead of one, there be several gases with different absorption co-efficients for photo-ionisation, there shall be several ionised layers. The ionosphere, in fact, is known to consist of two ionised layers; one due to photo-ionisation of molecular oxygen and the other to that of atomic oxygen. The two layers called the E- and the F-Regions are situated at heights of 100 and 250 kilometres respectively. Now if the temperatures of the two regions be the same, then, according to

⁷ Cabannes and Dufay, *Comptes rendus*, 198, 306, 1934.

⁸ Chapman, *Proc. Phys. Soc.*, 43, 26, 1931.

* The physical meaning of the scale height $H = kT/mg$ will be evident from the following. For a gas in diffusive and isothermal equilibrium on the surface of the earth the density ρ at any height h is given by $\rho = \rho_0 \text{Exp}(-h/H)$. It follows that the column of atmosphere above the height h , if compressed to the density ρ would occupy a height H . (The symbols have their usual significance; k Boltzman constant, T absolute temperature, m mass of the gas molecule and g acceleration due to gravity).

⁹ Babcock, *Astrophys. Jour.*, 57, 209, 1923.

the above expression (see footnote), the thickness of the F-layer should be double that of the E-layer because m for molecular oxygen is double that of atomic oxygen. Radio measurements¹⁰ show however, that the F-layer is on the average 5 to 6 times thicker than the E-layer. It is therefore obvious that a factor 2.5 to 3 of the increased thickness of the F-layer must be due to increased temperature. Since the temperature in the region of E-layer, as estimated from the scale height is 380°K , that in the region of the F-layer should be of the order of 1000° to 1150°K .

COLLISIONAL FREQUENCY IN THE REGION F OF THE IONOSPHERE

Measurement by radio method of the frequency of collision of electrons with gas particles in an ionised region furnishes another means of estimating the temperature of high atmosphere. The experimental observation consists in measuring the absorption suffered by radio waves on their reflection from the ionised region. Part of the trajectory of the ray associated with the wave lies within the ionised region itself and it is here that the absorption of energy occurs. The process of absorption is simple. The electrons in the ionised region abstract energy from the electric field of the advancing waves and are thereby set into oscillation. In the absence of collision there is, on the whole, no absorption of energy from the wave, as the energy abstracted by the electron is handed back by re-radiation. If, however, there be frequent collisions of the electron with gas molecules in course of the period of an oscillation, then the directed momentum of the electron is lost in the encounters and dissipation of energy from radio waves occurs. The amount of absorption suffered by the waves is thus a measure of the number of collisions which an electron with the gas molecules suffer. In order to compare the experimentally determined collisional frequency ($2.4 \times 10^3/\text{sec.}$) with the theoretically calculated value, it is necessary to know the density and the collisional cross-section of the colliding gas molecules. Now in the F-Region of the ionosphere, at a height of 250 km., the atmospheric constituents are atomic oxygen and molecular nitrogen, the former being the predominant one. The cross section for elastic collision of electron with atomic

oxygen has been calculated¹¹ for various electron energies. It is found that the observed collisional frequency agrees with the calculated one, if the density of the atmospheric gas and the cross-section

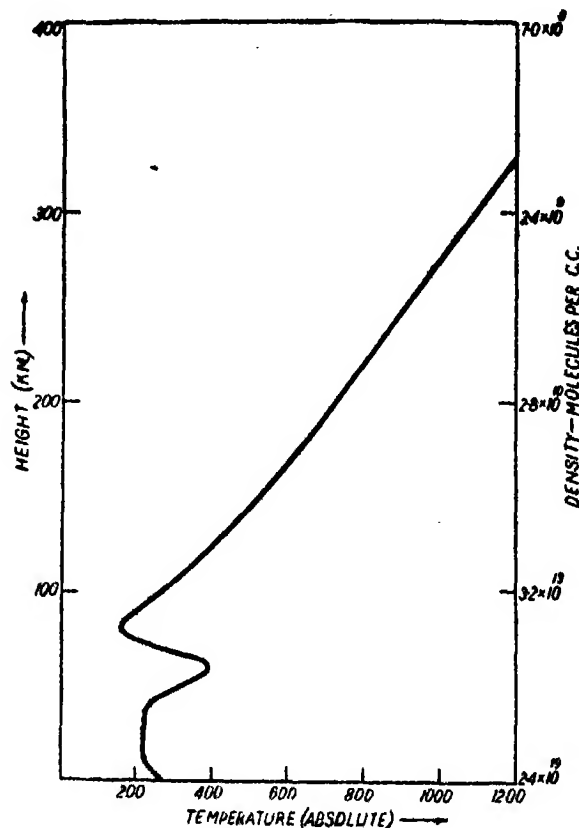


FIG. 4. Illustrating temperature variation of the atmosphere with height (After Martyn and Pulley). The temperature distribution up to about 35 km, is obtained from direct measurements by sounding balloons. The distribution above is obtained from various atmospheric phenomena. The existence of a high temperature beyond 100 km. is discussed in particular in the paper. The figures along the ordinate on the right indicate atmospheric density (number of molecules per c.c.) at various heights. (After Mitra and Rakshit).

of atomic oxygen be taken respectively as those corresponding to a temperature of 1000°K in the region of F-layer of the ionosphere.

CONCLUSION

The various upper atmospheric phenomena described above, point to the existence of a high temperature in the upper regions of the atmosphere. (Fig. 4). The available data do not permit of any accurate determination of its value, nor of its nature of variation with height. But there cannot

¹⁰ Appleton, *Q. Jour. Roy. Met. Soc.*, 65, 324, 1939.

¹¹ Mitra, Ray and Ghosh, *Nature*, 145, 1017, 1940.

be any doubt that the actual temperature is of the same order as that deduced above. According to some authors the temperature is variable, being higher at day by a few hundred degrees than at night. That the upper atmosphere should have a high temperature may also be concluded from the fact that the whole of the extreme ultra-violet spectrum of the sun is absorbed in the upper regions of the atmosphere and fail to reach the surface of the earth. The portion of the spectrum between 2100 and 2900 Å is absorbed by ozone in the middle atmosphere. The rest of the spectral energy below 2100 Å is undoubtedly absorbed by the constituent gases of the upper atmosphere, namely molecular nitrogen and, molecular and atomic oxygen. The primary effects of the absorption might be dissociation, ionisation or excitation of the constituent gas

particles; but, like all other forms of energy, the absorbed energy must ultimately degrade into thermal energy of molecular agitation causing a rise of temperature. It has been shown by Godfrey and Price¹² that the equilibrium temperature due to absorption of wavelength λ_{1450} by the oxygen molecules which have not been dissociated into oxygen atoms in the upper atmosphere, can be as high as 3300°K. If it be assumed that water vapour, which is a good radiator of heat, is also present in this region then the temperature attained may be considerably lower and be of the order of 1200°K.*

¹² Godfrey and Price, *Proc. Roy. Soc. A.*, 163, 228, 1937.

* The author has much pleasure in acknowledging with thanks the help he received from Prof. S. K. Mitra in the preparation of the article.

RESEARCH—NEW PRODUCTS—NEW JOBS

Fifteen million Americans now work at jobs which did not exist in 1900, said Everett S. Lee, head of the General Electric general engineering laboratory at Schenectady, in an address on the "Practical Applications of Research" at Providence, R. I., at a dinner of executives celebrating "Research Day in New England". "These jobs exist today," said Mr Lee, "because through research, industry has been able to develop hundreds of new products. And it has been able to make them so inexpensive that millions of people have been able to buy them". He said that there are now 1700 distinct research groups in America, employing some 50,000 workers and spending 150 to 200 million dollars a year, but that there is still room for more research. In 1938, he said, more than 150,000 manufacturing concerns were without research laboratories.

—*Journal of the Franklin Institute.*

Sir Prafulla Chandra Ray Eightieth Birthday Commemoration

AN APPEAL FOR FUNDS

Eminent Indians in all walks of life have issued the following appeal for funds to commemorate the eightieth birthday of our great scientist-philanthropist, Sir Prafulla Chandra Ray. It has been proposed that the income of the fund so collected will be devoted to the promotion of scientific and industrial research, a cause which is of the utmost consequence to the progress of India on modern lines and to which Sir Prafulla Chandra Ray has been devoted all through his life. We would fervently urge our fellow countrymen to respond generously to this appeal so that a fund worthy of the great name with which it will be associated may be raised. A strong Working Committee has been formed with Sir Nripendra Nath Sircar, himself an ex-pupil of Sir Prafulla Chandra Ray, as Chairman. All contributions should be sent to the Treasurer, Dr. N. N. Law, at 96, Amherst Street, Calcutta.

—Ed. Sc. and Cul.

ON the occasion of the completion of the eightieth year of Sir Prafulla Chandra Ray (August 7, 1941), it has been proposed by his friends, admirers and ex-pupils to raise a fund with which his name will be associated. The income of the fund will be devoted to the furtherance of scientific and industrial research in India, a cause which Sir P. C. Ray has advocated all his life.

It is superfluous to acquaint the public with the manifold services which Sir P. C. Ray has rendered to the country. Even while a student at Edinburgh he thought deeply about the political condition of India and produced a pamphlet which excited wide interest. As a young professor, he devoted years of work to finding out from original sources an exact estimate of the contribution of ancient Indians to the science of chemistry. The result has been his monumental History of Chemistry in ancient India as yet unsurpassed by any modern work. As professor of chemistry in the Presidency College, and later as Palit professor of chemistry of the University College of Science, Calcutta, two generations of students, many of whom now occupy very prominent positions in the

public life of India, sat at his feet and received from him not only their knowledge of chemistry, but inspiration for a new life as well. In mature years, he was the founder and main inspirer of the Indian

school of chemistry. He has also been associated with almost every philanthropic activity in this country and has organised large-scale relief work in times of flood and famine. In 1918, as a member of the Chemical Services Committee, he fought hard for the promotion of industry by the Government. He has founded big chemical industries himself, which have brought wealth to the country, and has inspired the promotion of a large number of other industrial and commercial enterprises. And above all, as a rational thinker, he has preached the gospel of science and industry in this country.

Had Sir P. C. Ray cared to retain for himself a tithe of the remuneration which he might have justly demanded as his share in the promotion of large-scale industries, he might have had by this time a prince's income. But he has always disdained wealth and has given away his earnings to the poor, to needy schools and colleges and other



educational institutions and, in general, for the alleviation of human distress, leading all the time the simple life of an ascetic. It is the duty of his countrymen to honour him in a befitting manner and no monument will be more enduring than a fund named after him which will be devoted to the promotion of industrial and scientific research in this country.

Even after passing four score years he is quite fresh and vigorous in mind and is taking his full share in the activities for the advancement of the country. We hope that while he is still with us, it will be possible to raise this fund and devote it to the purpose dearest to his heart.

Pramatha Nath Banerjee	N. R. Dhar	Bijoy Chand Mahatab	C. R. Reddy
Sailendra Nath Banerjee	J. M. Dutt	R. C. Majumdar	Asoke K. Roy
J. N. Basu	Ashutosh Ganguli	Suresh Ch. Majumdar	Bidhan Chandra Roy
P. C. Basu	J. J. Ghandy	R. P. Masani	Jadunath Roy
S. S. Bhatnagar	J. C. Ghose	Jivraj N. Mehta	Birbal Sahni
G. D. Birla	Tushar Kanti Ghosh	Gaganvihari L. Mehta	Ruchi Ram Sahni
Jugal Kishore Birla	Badridas Goenka	Biren Mookerjee	Tej Bahadur Sapru
Charu Chandra Biswas	Maurice Gwyer	Syamaprasad Mookerjee	Ambalal Sarabhai
Sarat Chandra Bose	M. Azizul Haque	Manmatha N. Mukerjee	Nalini Ranjan Sarker
Subhas Chandra Bose	Mian Md. Afzal Hossain	P. N. Mullick	Srinivas Shastri
U. N. Brahmachari	A. K. Fazlul Huq	G. A. Natesan	Abdur Rahman Siddiqi
C. V. Chandrasekharam	Akbar Hydari	Jnananjan Neogi	Sachchidananda Sinha
Ramananda Chatterjee	Mirza Ismail	Rajendra Prasad	Nilratan Sircar
Sanmukham Chetty	Amarnath Jha	S. Radhakrishnan	H. S. Suhrawardy
R. N. Chopra	D. P. Khaitan	Shri Ram	Shah Md. Sulaiman
A. R. Dalal	Kasturibhai Lalbhai	C. P. Ramaswamier	Rabindra Nath Tagore
G. V. Deshmukh	S. C. Law	N. S. Subba Rao	T. Vijayaraghavachariar
			M. Visvesvaraya

N. N. Sircar
(Chairman)

M. N. Saha and B. C. Guha
(Secretaries)

N. N. Law
(Treasurer)

P. C. Mitter

J. N. Mukherjee

Prafulla K. Bose

Notes and News

Carnegie Institution of Washington

THE *Year-Book* of the Carnegie Institution (No. 38) covering the year July 1, 1938—June 30, 1939 has been issued. It includes the annual reports of the various departments under the management of the Institution, namely, the Mount Wilson Observatory, the Geophysical Laboratory, the Department of Terrestrial Magnetism, the Division of Plant Biology, the Division of Animal Biology and the Division of Historical Research. It also includes reports on investigations carried on in co-operation with other learned bodies like the Committee of Co-ordination of Cosmic Ray Investigations. The staff of the Mount Wilson Observatory are co-operating with the physicists and engineers of the California Institute of Technology in the construction and erection of the 200-inch telescope. The Department of Terrestrial Magnetism held a conference on ionosphere and another on theoretical physics. The Division of Plant Biology carried out important work on photosynthesis, and the work in the Department of Animal Biology included studies on the physiology of reproduction, endocrine studies, and investigations on the chromosome and the gene.

U. S. Register of Scientific Workers

SCIENCE Service, of Washington, announces that a National Register of Scientific and Specialized Personnel in the United States is being compiled on lines similar to those used in Great Britain. The index is being made by the National Resources Planning Board and the U. S. Civil Service Commission and the other organizations co-operating in the scheme include the National Research Council, American Council on Education, American Council of Learned Societies and the Social Science Research Council. Committees of specialists widely acquainted with various fields of learning will assist in classifying the index and will also be charged with protecting the present educational and research endeavours which are carrying out important public

services. The register will not be abandoned with the passing away of the present emergency but will be maintained as an up-to-date census of the specialized brains of America and will provide a means for the efficient and rapid but appropriate use of the specialized brains in the service of the nation.

Annual Exhibition of the Carnegie Institution

THE Carnegie Institution of Washington arranged to hold their annual exhibition in December when exhibits illustrating some of the recent work done in their various departments and laboratories were displayed. The Geophysical Laboratory displayed an exhibit showing some applications of an apparatus which could produce extremely high pressures in the neighbourhood of 3 million pounds per square inch. This pressure corresponds to that found at a depth of 300 miles below the earth's surface. The apparatus thus enables to study in the laboratory the behaviour of metals and minerals under actual conditions as are found in the interior of the earth. An interesting result has already been observed; ferromagnetic substances which under ordinary conditions lose their magnetism at certain high temperatures are found to retain their magnetism under such high pressures. This experiment supports the view that the earth's magnetism may be accounted for by the presence of magnetic materials in the interior of the earth which retain their magnetism even at the high temperature prevailing there.

Another interesting exhibit was the exhibit of the Division of Plant Biology, consisting of leaves of fossil plants and leaves from their living relatives showing the large-scale climatic changes in the Pacific North West which has resulted in the southward migration of the old forests during the last 50 million years. The Mount Wilson Observatory arranged an exhibit consisting of photographs and charts illustrating new developments in the study of supernovae.

Industrial Research Utilization Committee

A BOARD of Scientific and Industrial Research was set up by the Government of India in April, 1940 to ensure co-ordinated development of Indian industries, particularly of those, the importance and possibilities of which were prominently brought to the foreground as a result of war conditions. Some of the research schemes instituted at the instance of the Board have borne satisfactory results and the possibility of their industrial utilization has been proved to the satisfaction of the Board. The Government of India have now set up a committee of non-officials to be called the Industrial Research Utilization Committee whose main function will be to advise the Government regarding the selection of industrial concerns to which results of research schemes should be made available for utilization and to advise on the best methods whereby the industrial development of the research schemes can be undertaken. The final decision on all matters on which the advice of the Committee is sought however rests with the Government of India. The Committee will consist of Sir Ramswami Mudaliar (Chairman), Sir Shri Ram, Sir Ardeshir Dalal, Sir Homy Mody, Sir Sultan Ahmad, Mr Kasturibhai Lalbhai, Mr P. F. S. Warren, Dr N. N. Law, Mr J. H. S. Richardson, Sir Frederick James, Sir Rahimatullah Chinoy, Sir Jawla Prasad Srivastava, Sir Saiyed Martab Ali Shah, Sir Abdul Halim Ghuznavi, Mr C. S. R. Mudaliar, Mr N. R. Sarker, Mr F. Stones and Sir Santi Swarup Bhatnagar with Mr T. S. Pillay as secretary.

At the first meeting of the Committee held at Delhi on February 12, Dr Bhatnagar gave a rough idea of the schemes of research which had matured and were capable of immediate industrial utilization. The Committee decided that research schemes which can be exploited without much capital investment or as cottage industries may be released to the public without any conditions regarding royalty. The Committee also recommended that the royalty received from industrial concerns should be constituted into a separate fund for the further development of industrial research. The Committee also approved a proposal to publish a journal entitled "Indian Industry" containing information relating to industrial research and its utilization. "SCIENCE AND CULTURE" has always aimed at dissemination of knowledge and information relating to industrial research and its utilization in India, and for the last four years has published a separate section "Science in Industry" entirely devoted to this purpose. We are glad to note that the Committee has appreciated the necessity and importance of dissemination of such information in the country.

Annual Meeting of the Royal Asiatic Society

In his presidential address delivered at the last annual meeting of the Society, the Hon'ble Justice Sir John Lort-Williams deplored that the support of local European men of culture to which the Society owed its inception and success at its initial stage is fast disappearing. The European in India today shows little intellectual endeavour or cultural activity as compared with his predecessors of the eighteenth or early nineteenth century. The future activities of the Society will more and more devolve on Indian scholars as the years pass. But we regret to note that in elucidating the future aims and objects of the Society, the president makes a distinction between specialists, professional scholars and men of broad culture and expresses the hope that in future the Society will be a meeting ground of the latter class. Two years ago we were constrained to remark in these columns that among a section of members of the Society there was a tendency to turn the Society into a club for rich 'cultured' people. However, within the last two years, as a result of the recommendations of a special enquiry committee, there has been reorganisation and overhauling of the work of the Society resulting in some improvement and progress. But the tone of the presidential address, we are sorry to remark, surely goes against the spirit in which the Society was founded by its first president, Sir William Jones, and was worthily maintained till recent times by his successors.

The Sir William Jones memorial medal awarded biennially for the most eminent work in advancing the objects of the Society, was awarded this year to Sir P. C. Ray.

The following office-bearers were elected for the year, 1941.

President—The Hon'ble Justice Sir John Lort-Williams; *Vice-Presidents*—Col. Sir R. N. Chopra, Dr C. S. Fox, Dr Syamaprasad Mookerjee, Sir S. Radhakrishnan; *General Secretary*—Dr B. S. Guha; *Treasurer*—Dr Bains Prasad; *Philological Secretary*—Dr S. K. Chatterjee; *Joint Philological Secretary*—Mr M. Mahfuz-ul Haq; *Natural History Secretaries: Biology*—Dr Kalipada Biswas, *Physical Science*—Dr Meghnad Saha; *Anthropological Secretary*—Mr H. C. Chakladar; *Philosophical Secretary*—Pandit Vanamali Vedantatirtha; *Historical and Archaeological Secretary*—Dr Kalidas Nag; *Medical Secretary*—Major C. L. Pasricha, and *Library Secretary*—Dr J. N. Mukherjee. The other members of the Council included Dr S. C. Law, Dr M. Z. Siddiqi, Mr. C. W. Gurner and the Hon'ble Mr Justice N. G. A. Edgley.

Compulsion for Eradication of Agricultural Pests

AGRICULTURAL pests and diseases of crops often do considerable harm to the crops raised by agriculturists in various parts of India. Extensive investigations made by the agricultural department as to the best methods of preventing or reducing such damage have in many cases been successful in providing control or remedial measures. In dealing, however, with any contagious or infectious crop disease, or any infestation by noxious insects, control or remedial measures to be effective must be applied over the complete area affected. If small portions of affected area are left untreated, these will form reservoirs whence the trouble will inevitably spread to those parts from which the pest has been eradicated. Such a contingency arises if any cultivator is not willing to co-operate in taking the necessary measures or precautions against a pest.

Unfortunately in some areas despite propaganda and explanation to the cultivators of the necessity of united action, unwillingness of a small number of cultivators to adopt the necessary measures, seriously reduces the efficacy of the measures taken. It is certainly unfair that the intelligent and energetic farmer should suffer from the ignorance or indifference of others and a measure of compulsion should be applied in such cases to ensure that the crops of a majority should not be damaged or ruined by the slackness of a small minority. In Madras the Agricultural Pests and Diseases Act, which enforces such compulsory measures has been in force for a number of years. The Bombay Government is now considering the desirability of passing a similar Act for the benefit of agriculture in that province. Necessary precautionary or ameliorative remedies against agricultural pests and diseases will be enforced, and, where the owner neglects to comply with orders, the necessary remedy will be applied by the Government and the cost recovered from the owner.

Improvement of Livestock

THE low efficiency and the milk yield of the cattle in our country are primarily due to insufficiency of food of the right type and of promiscuous breeding. The shortage of fodder is due to the poor condition of grazing grounds and more so to the heavy incidence, the useless cattle competing with the essential. It has also been observed that cattle relying primarily on grazing grounds in close proximity to forests are far inferior to those in the intensively cultivated tracts where they are stall-fed with cultivated fodder or straw. Mr K. P. Sagreya in a paper (*Bulletin* No. 2, Forest Department, Central

Provinces and Berar) analysing the problem mainly from the provincial standpoint has suggested that efforts must be made to enforce (i) castration of emaciated bulls, (ii) selective breeding, (iii) discrimination between the essential and the surplus livestock and favouring of the former at the expense of the latter by differential rates, and to encourage (iv) cultivation of fodder crops by reducing the land revenue on lands under such crops, (v) better utilization of grass from remoter tracts as hay or silage, and (vi) improvement of the grazing grounds.

Already experiments have been started to find out the most practicable methods of making better grazing available from the reserved forests. Studies are under progress on the effects on grazing grounds and grass lands of (i) different incidences and grazing-closure cycles, (ii) burning, (iii) weeding, (iv) reseedling, (v) manuring, etc. In this connection commercial possibilities are being explored for converting into silage the grass in the remote reserved forests where its rank growth only hampers regeneration of tree species and increases the fire-hazard. The grass is likely to find its way to consuming centres for sale at a nominal price, and a *via media* is expected to be found out between the insistent demand of extra lands for pasture purposes and the necessity of protecting forests.

Sugarcane Research in India

A SHORT account of the progress attained in sugarcane research in this country entitled "A summary of some practical results of sugarcane research in India" has been published as *Miscellaneous Bulletin* No. 34 of the Imperial Council of Agricultural Research. Results of practical utility obtained up to and including 1937-38 have been incorporated in the Bulletin, which is non-technical in style and a valuable publication for sugarcane growers and factory owners possessing their own plantations.

The memoir gives a general description of sugarcane cultivation in different provinces with special reference to area under improved types. This is followed by a detailed description of behaviour and distribution of the present-day popular varieties. The range of possibilities of improvement in yield, by a comparison of the behaviour of different types in important sugarcane belts of the country; improvement in cultural methods, rotations and ratooning are also noted under different headings.

Manuring of sugarcane, including the use of molasses and green manuring, are dealt with fully. The relative usefulness of nitrogen, phosphorus and

potash are discussed and the optimum rate of various nitrogenous manures, their useful combinations and best times of their application found as the result of trials in different parts of the country are discussed.

A chapter is devoted to pests and diseases and possible control measures. Academic studies of a chemical and physiological nature and root studies in so far as they have yielded useful indications of results of practical value have also been incorporated.

A New Link in India's Past History

IMPORTANT discoveries which might help in filling up some of the gaps in India's ancient history are expected to be made at Ramnagar in the Barilly district of the United Provinces. The site has been identified as the city of Ahichchatra, the capital of ancient Panchala. The city is on an elevated triangular tableland of rolling mounds, covered with thick layers of bricks and potsherds, surrounded by a broad brick wall, rising in places to nearly 50 feet above the low plain outside. The wall shows bastions and angles at various points and is nearly three-and-a-half miles in circuit. The bricks used in the wall are unusually large, being 21 to 24 inches long, indicating an early age, from 100—300 B.C. Two high mounds, 30 to 50 feet high, stand inside the city and seem to be the remains of terraced temples, but there is nothing in the configuration of the mounds to distinguish different parts of the ancient city. A broad partition wall appears to run from north to south dividing the city into two unequal parts, the eastern one being smaller than the western. Excavations are in progress in the western part, over an area of about 350 feet each way, where several houses, lanes and streets have been brought to light.

The temples and houses of the city that have been exposed so far appear to belong to the epoch of the Gupta Empire (400-500 A.D.). The city seems to have been evacuated sometime about the Hun invasions of the fifth century A.D. and must have been in existence for nearly a thousand years before desertion. As excavation proceeds layer by layer earlier occupations will reveal themselves. The findspot of every object both as regards position and depth is being accurately recorded, even in the case of commonest objects like pottery. This will prove a basis for studying the sequence of pottery, as has been done with conspicuous success in Egypt and other ancient countries.

Besides yielding important historical results, the excavations at Ramnagar form the first training

camp for junior officers of the Archaeological Survey and scholars and apprentices both of the Government of India and the Indian States.

Report of the Royal Society

THE Report of the Council of the Royal Society for the year ending October 31, 1940 records that in its long history of traditional co-operation with the Government the year under review forged the most intimate contact, culminating in the setting up of a Scientific Advisory Committee to the War Cabinet. A short notice of this Committee was made on page 282 of the November 1940 issue of SCIENCE AND CULTURE. This Committee, appointed by the Lord President of the Council after discussion with the Officers of the Society and with the approval of the Prime Minister, is (a) to advise the Lord President on any scientific problem referred to it, (b) to advise Government departments, when so requested, on the selection of individuals for particular lines of scientific inquiry, or for membership of committees on which scientists are required, and (c) to bring to the notice of the Lord President promising new scientific or technical developments which may be important to the war effort. The constitution of the Committee is as follows: *Chairman*, Lord Hankey, Chancellor of the Duchy of Lancaster; *members*, Sir William Bragg, O.M., as president of the Royal Society, Professor A. V. Hill and Professor A. C. G. Egerton, as secretaries of the Royal Society, Dr. E. V. Appleton, as secretary of the Department of Scientific and Industrial Research, Sir Edward Mellanby, as secretary of the Medical Research Council, and Sir Edwin Butler, as secretary of the Agricultural Research Council; *joint secretaries*, Group Captain W. Elliot and Professor W. W. C. Topley.

Many of the fellows of the Society are actively at work in own spheres or on deputation on problems having a vital bearing on the health, feeding and protection of fighting men and civilians under war conditions. Under Society's initiative, a committee was appointed to advise the Home Office on the release or exemption from internment of aliens whose work was considered to be of importance in the promotion of science, not exclusively in relation to the national war effort. This initiative has been followed up for persons who were engaged in other vocations, namely university teachers, medical men, musicians, artists, etc. The Society for the Protection of Science and Learning prepared the applications. The Society's work is progressing on the compilation of the Central Register (section for scientific research) and the Society's copy has been

requisitioned by the Ministry of Labour and National Service.

The war has naturally affected the normal research activities of the Society. Many holders of research appointments have undertaken work in the national interest; others have been forced to modify their programme owing to changed circumstances. The Council has recommended to the Treasury after consultation with the Woods Hole Oceanographic Institution not to discontinue research into Atlantic Drift problems at the Bermudas. Some of the apparatus prepared for the eclipse expedition to South Africa were sent out to the Cape observers. Regarding Society's publications there has been as well some curtailment due to rationing of paper supplies. The Council considered necessary to impress upon authors, more particularly of the type of papers as published in the *Philosophical Transactions* the desirability of confining their papers to a description and discussion of new results.

The Imperial Chemical Industries contributed £1,000 to meet the cost of the Society's publications. The late Sir Henry Head, F.R.S., has bequeathed his residuary estate for research in medical science, which is expected to yield more than £100,000. The Society has accepted, in accordance with the wishes of the late Professor A. Smithells, a packet of letters and papers containing biographical material relating to the late Lord Rutherford, which will not be opened before 1 January, 1987.

Announcements

At the twentieth annual meeting of the INDIAN BOTANICAL SOCIETY held at Benares on the 3rd January, 1941, the executive council was constituted as follows:

President—Professor S. L. Ghose (Lahore), *Vice-Presidents*—Dr H. Chaudhuri (Lahore), Dr Shri Ranjan (Allahabad), *Secretary*—Professor Y. Bhara-dwaja (Benares), *Treasurer*—Professor M. O. P. Iyengar (Madras), *Elected Members of the Executive Council*—Dr P. L. Anand (Lahore), Dr K. Biswas (Calcutta), Dr Rafique A. Khan (Aligarh), Dr B. C. Kundu (Calcutta), Rai Bahadur Professor K. C. Mehta (Agra), Dr R. N. Nirula (Nagpur), Dr B. P. Paul (New Delhi), Principal P. Parija (Cuttack), Professor B. Sahni (Lucknow) and Rai Sahib Kalidas Sawhney (Parbhani-Deccan).

The third annual general meeting of the ENTOMOLOGICAL SOCIETY OF INDIA was held at Benares on the 3rd January, 1941. The General Secretary's

annual report showed that at the end of 1940 the Society's membership had reached a total of 114. The main activity of the Society was the publication of the *Indian Journal of Entomology*. The Society's branches at Lyallpur, New Delhi, Pusa, Calcutta, Coimbatore and Karachi are maintained.

The following office-bearers were elected for 1941: *President*—Dr T. V. Ramakrishna Ayyar (Coimbatore), *Vice-Presidents*—Dr N. C. Chatterjee (Dehra Dun), Dr Khan A. Rahman (Lyallpur), *General Secretary*—Dr Taskhir Ahmad (New Delhi), *Joint Secretary and Treasurer*—Mr H. L. Bhatia (New Delhi), *Councillors*—Mr J. C. M. Gardner (Dehra Dun), Mr S. K. Sen (Mukteswar), *Members of the Editorial Board* (in new vacancies)—Dr K. B. Lal (New Delhi), and Mr S. K. Sen (Mukteswar).

With the object of cultivating and promoting the study of plant and animal ecology by closer co-operation among different branches of science, viz.—the botanist, the zoologist, the geologist, the meteorologist, the agriculturist, the soil scientist, the chemist and the geographer—the INDIAN ECOLOGICAL SOCIETY was inaugurated at Benares during the Science Congress session and the following were elected to the executive committee of the Society for 1941: *President*—Prof. S. P. Agharkar of Calcutta University, *Vice-President*—Dr N. L. Bor of Forest Research Institute, Dehra Dun and Dr S. L. Hora of Zoological Survey of India, Calcutta; *Secretary and Treasurer*—Dr F. R. Bharucha of Bombay; *Members*—Mr P. W. Davis, of Ootacamund, Prof. P. W. Gideon of Karnatak College, Dharwar, Dr R. D. Misra of T. N. J. College, Bhagalpur, Dr L. A. Ramdas of the Observatory, Poona, Dr T. S. Sahnis of Cawnpore. The office is located at Royal Institute of Science, Bombay 1.

New rules have been made to enable bonafide research students in India, including university professors and readers and certified post-graduate scholars, to inspect and copy without any restriction from all documents, from the earliest times down to 1880, in the custody of the Imperial Record Department, Government of India. The admission to the archives is absolutely free and though the extracts taken from the records are to be examined by the Keeper before their release, there is no examination fee. Complete information about the conditions of admission not only to the various public record offices in India but also to the public and private archives in European countries has been published in the *Manual of Rules Regulating Access to Archives in India and Europe*, just published by

the Imperial Record Department. The Manual was compiled on the recommendation of the Indian Historical Records Commission.

Acknowledgment

We acknowledge with thanks the receipt of the following :

1. Annual Report of the Chief Inspector of Mines for the year ending December, 1939.
2. Proceedings of the First All-India Sericultural Conference.
3. Scientific Reports of the Imperial Institute of Sugar Technology.
4. Research Publication No. 3 of the Central Irrigation and Hydrodynamic Research Station, Poona. This contains a note by C. C. Inglis and D. V. Joglekar on the theory, design and construction of gibbs modules, which without moving parts

give a constant discharge within working limits, irrespective of variations in upstream and downstream water levels.

5. Report on the Marketing of potatoes in India and Burma.

Corrections

In the last February issue in the article entitled Electron Microscope, on p. 442, the last line of the left column

bids fair to show that it will soon prove itself to be should come above Fig. 5 on the same page and read after "But it".

In the same issue in another article entitled 'How far Census in Bengal is Accurate, on p. 446 the 3rd line from top of the right column should read '*affect them directly*'. The subheading—1931 examined—was a wrong interpolation.

PLANNING FOR PROGRESS

There was justification for the belief that agriculture would long be concerned with the production of food crops. A realisation of importance of dietary values in the nutrition of man and of live-stock might lead in some cases to an increased demand, but it is a fact that serious difficulties has already arisen in connection with the disposal of certain food crops.

No one, however, would be so rash as to forecast that there would be no change in the agriculture of the future. Secondary industries even now are using larger and larger quantities of agricultural products as raw materials.

One manufacturing firm in U. S. A. spent \$14,000,000 last year in the purchase of agricultural products for use in chemical industry. Four years ago, the entire crop of soyabeans from 50,000 acres was utilised in connection with automobile manufacture by one organisation alone in U. S. A. Who would say that larger quantities of crops would not be grown for the production of power alcohol? It had been suggested, too, that the weed of today might well be the crop of tomorrow.

Whatever the situation, it is essential that people should have much more detailed information on their present resources. That is necessary not only for present wartime requirements, but also for the inevitable reconstructional period.

It is accepted that vast social, economic as well as technical problems had yet to be solved, but they should be as ready to see possibilities as they are to discover difficulties or dangers. Planning under such conditions is no easy task, but the achievements of the past might well be accepted as an index of still further successful achievement in the future.

—With acknowledgment to the *Agricultural Gazette of New South Wales*.

SCIENCE IN INDUSTRY

Chemical Technology Researches

At the last session of Science Congress at Benares 61 papers embodying researches on industrial chemistry were presented. Of these some deserve attention as their results indicate commercial exploitation possible. At the Indian Institute of Science, Bangalore, manufacture of acetic acid by the decomposition of lime acetate by sulphuric acid was studied and 80% crude acetic acid was obtained in a copper plant made there. In this experiment 57 lbs. of acetate produced at Bhadravati gave about 40 lbs. of crude acid in a day. The concentration of the 80% acid to glacial acetic acid by azeotropic distillation using various entrainers has been effected. The extraction of acetic acid direct from pyroligneous acid, the manufacture of ethyl acetate using lime acetate, alcohol and hydrochloric acid; of sodium acetate from weak acetic acid fractions, and acetic anhydride from sodium acetate are under investigation.

Exact conditions for the electrolytic preparation of hydrogen peroxide have been investigated at Royal Institute of Science, Bombay. Ammonium persulphate has been prepared by the electrolysis of a concentrated solution of ammonium sulphate by the chromate method using a current density of 250 amps. per sq. ft. and at various concentration of H_2SO_4 in the electrolyte. The current efficiency has been found to be 73%. It was found that a preliminary heating of ammonium persulphate with sulphuric acid is necessary to get a fairly good yield of hydrogen peroxide by distillation in vacuum. The yield has been found to be 80% of the theoretical amount of hydrogen peroxide. Potassium persulphate under similar conditions has been found to give a yield of 84%.

Town refuse, consisting mostly of dung of various animals such as donkey, cow, buffalo, camel, goat, etc., on burning has yielded crude ammonium chloride in an investigation at the Industrial Research Laboratory, Lahore. The refuse is burnt in old types of brick kilns, and the issuing fumes are deposited on the cooler side (exposed to air) of the bricks. It has

been found that when the scrapings are lixiviated with water and concentrated, crystals can be separated by centrifuging. Further purification is done by sublimation. Ammonium chloride produced is quite pure and is reported to be competitive in price with the foreign material. The process of preparation has been demonstrated in the locality and a factory has come into existence.

Another interesting investigation is proceeding at Benares Hindu University on the electro-synthesis of potassium permanganate from potassium nitrate and pyrolusite.

Removal of Sulphur from Tertiary Coals

The attention of coal producers of Assam and N. W. India has been drawn in a paper presented at the geology section. The author belonging to geology department of Presidency College, Calcutta mentions that coke produced from the Tertiary coals of India contains a high percentage of sulphur, and for this reason it is not being used in high class smelting operations. Various methods are discussed by which sulphur may be appreciably reduced: (i) by quenching red-hot coke; (ii) by passing hydrogen over red-hot coke; (iii) by subsequent quenching of the red-hot coke from (ii); (iv) by action of volatile chlorides such as sodium chloride; and (v) by ammonium chloride. The author has carried out experiments in the laboratory with specimens of (a) Namdang coal, and (b) Watching coal from upper Assam.

The coal specimens that were carefully selected for laboratory investigation contained only negligible quantity of pyrites but have very high percentage of organic sulphur, i.e., 2.66% and 4.54% respectively. The Namdang coke contains 2.56% and Watching coke has 4.11% sulphur.

The author has shown that by quenching red-hot coke with water, less than 1% and by passing hydrogen over red-hot coke 40% of sulphur content could be removed. By sodium chloride treatment about 60%, and by ammonium chloride 30% of the sulphur

content could be eliminated. In the first four methods the quantity of coke does not deteriorate, whereas in the case of ammonium chloride the coke obtained was loose and friable.

Acharya Prafulla Chandra Exhibition

IN connection with the celebration of Sir P. C. Ray's 80th birthday in August next, the Commercial Museum of the Corporation of Calcutta has decided to hold an exhibition of chemical and pharmaceutical industries. A meeting of chemists and chemical industrialists was held under the auspices of the Commercial Museum to form an advisory board for the proposed exhibition and Dr B. C. Guha, Ghose professor of applied chemistry, University College of Science, Calcutta, has been elected chairman of the board. The organisers of the exhibition hope to give a retrospective survey of the achievements already scored; and to illustrate the prospects of potential industries in India. It will be an exhibition of newer types of chemical and pharmaceutical products prepared on scientific lines and preferably from indigenous materials. The exhibition will be an index of the success of our efforts in developing chemical and pharmaceutical industries. It is expected to indicate how to mitigate our tragic dependence on imports from foreign countries by utilizing Indian resources and materials which are yet waiting to be tapped.

Acharya Ray has inculcated a real spirit of research for the development of chemical industries in India. So it has been decided to devote a special section in the exhibition to demonstrate and popularise the scientific investigations having industrial possibilities which are being conducted in the different laboratories of the universities and in other technological and scientific institutes in India. Endeavours will be made to have a careful and representative selection and to give preference to those products which are prepared largely from indigenous materials.

The exhibition will have eleven chief sections:—

(1) A historical survey of the evolution of the chemical industries in India since 1890, (2) exhibition of chief products—heavy chemicals, acids and alkalies, (3) drugs and drug sources, (4) vegetable and forest products other than drugs, (5) minerals and their products, (6) coal and by-products, (7) marine products, fish oils, weeds, etc., (8) synthetic products other than drugs, (9) fuel research, (10) research exhibits from laboratories, and (11) miscellaneous.

The exhibition is proposed to be held by the 21st of March and will be kept open for a fortnight. We

join in the appeal issued by the Commercial Museum to the industries, research laboratories and to other relevant sources all over India for an effective collaboration by them to make this exhibition a success. Further information may be had at the office of the Museum at College Street, Calcutta.

Research Bureau's Work

THE annual report of the Industrial Research Bureau for the year 1939-40 gives a summary of the proceedings of the fifth session held in August, 1939 of the Industrial Research Council, which is the advisory body connected with the Industrial Research Bureau and consists of directors of industries of the provinces and principal States, officers of the Government of India, and nominated industrialists and scientists.

The Research Branch at the Government Test House, Calcutta, are continuing the work on the improvement of paints and on indigenous paint materials, on the manufacture of efficient dry cells with Indian raw materials, and on the utilization of vegetable oils as internal combustion engine lubricants or fuels. They carried out investigations to aid the glass industry, and tests to aid the growing electric lamp industry. Work on road research has begun on the road test-track at Majerhat.

The Bureau published bulletins on Indian refractory clays, titanium oxide recovery, the manufacture of liquid gold and of china glass for use in the ceramic and glass industries, and the utilization of Indian vegetable oils as lubricants or fuels in engines. Arrangements have been made for the publication of bulletins on the leather, handloom, and silk industries and on other industrial subjects.

The staff and consequently the activities of the Bureau suffered considerable curtailment at the outbreak of war, but the Bureau, including the Research Branch, were subsequently merged into the organisation of the Director of Scientific and Industrial Research.

Steel Substitute from Volcanic Rock

ACCORDING to a Consular report to U. S. A., basalt is being used as a substitute for steel plates in Germany. Basalt is a dense to glassy, dark-coloured, basic, volcanic rock, composed essentially of soda-lime felspar and pyroxene; with or without olivine and with accessory magnetite or ilmenite or apatite.

A special process has been developed to overcome the inherent brittleness of the stone. Crushed and graded basalt stones are fed into large furnaces and melted at a slightly higher temperature than that of the melting point of iron. The operation is continuous and the casting process similar to that of steel. In order to remove the brittleness of the cast articles or plates an elaborate tempering treatment is necessary. For this purpose the white-hot moulds pass through a number of tempering kilns, remaining in the last one for 56 hours. As a result, the basalt acquires a very dense needle-like crystalline structure. It is claimed that tempered basalt resists wear and tear better than almost any other known product. It has a pressure resistance of almost equal to that of iron, and a tensile strength about equal to that of glass.

The Government Material Testing Laboratory in Berlin gives the following specifications for tempered basalt :—

Specific gravity	...	2.8 to 2.9
Resistance to pressure	...	6000 kg/ sq. cm.
Flexibility	...	300 kg/ sq. cm.
Tensile strength	...	220 kg/ sq. cm.
Hardness	...	8 to 9 Mohs.

It is being used in Germany in cases where high degree of resistance against abrasion is desired. It is claimed that hardened carbon steel with 1 per cent of carbon content, resists abrasion to only about half the extent of tempered basalt. The applications to which tempered basalt is being put in Germany include the lining of equipment for handling coal, coke and ores, the lining of acid chambers, and as industrial flooring materials.

It is reported that a basalt deposit occurs in Deccan.

N. K. S. G.

Chemical Technology Department of Bombay University

We have received the annual report for 1939-40 of the department of chemical technology of University of Bombay. The work of the department is divided into three categories: training of students in textile chemistry and chemical engineering, research into allied problems and technical help for related industries.

It is gratifying to note that the demand for reprints of the research papers published by the department has been gradually increasing from mills and other industrial concerns. The department's

successful contact with the textile and other chemical industries of the province is evidenced by the absorption of its graduates, the subsidies received for industrial research and the increasing amount of analytical work and technical investigations submitted to the department. This latter work has added Rs. 8000/- to the annual income of the department. Processes for the manufacture of the following products were investigated with the aid of subsidies from industrial organisations: sodium nitrate, sodium sulphide, potassium and sodium dichromate, chromium salts, a desizing agent in powder form suitable for the textile industry, ephedrine from ephedra herb by a process not involving the use of solvents, β -naphthol, hydroxynaphthoic acid, and salicylic acid, glacial acetic acid and potassium acetate, paraffin emulsions, and sulphonated oils.

The conditions created by the war brought in a number of enquiries regarding schemes for the indigenous manufacture of products normally imported from abroad. These were the manufacture of electrolyzers for the cotton industry, of phosphorus and phosphatic compounds from raw bones, of plastics from casein, of bichromate from Indian chrome ore, the prevention of fungus growth in cement, the utilisation of the fat of *Vateria indica* (Dhoo), Indian cellulosic materials for the manufacture of rayon, and the preparation of paint oil from cotton seed oil.

New Alloy for Steam Turbines

THE research staff of the General Electric Research Laboratory at Schenectady have found that columbium, a relatively unfamiliar element and with very little commercial importance at present, when added in small portions in iron, produces an alloy of exceptional properties. There is no carbon in the new alloy, so it is not a steel. The iron contains the columbium as a finely dispersed stable compound of iron and columbium. The alloy containing three per cent of columbium and the balance iron, has exceptionally good rupture strength at 1100°F., a temperature not yet commercially used but being approached by modern high temperature high-pressure steam turbines. It is expected that the new alloy will make it possible to extend further the temperature at which steam turbines are operated at present.

N. K. S. G.

A Huge Tire

THE Firestone Tire & Rubber Co., U. S. A., has recently built the largest tire in the world which is to be used for a huge earth scraping and hauling

equipment. The tire is 10 feet high, 39 inches in cross-section and has a carrying capacity of 55,200 pounds.

The tire weighs, with its tube and flap, 3646 pounds, which is greater than the weight of many passenger cars. At the thickest part of the tread, the tire measures 5 inches of rubber and cord fabric. To build a single tire, more than 1.5 bales of cotton, more than 0.75 ton of crude rubber, 0.5 ton of other compounds, and 60 pounds of steel wire were used. The wheel required for this gigantic tire will be 40 inches in diameter, 26 inches wide, and will have a flange 6 inches wide.

N. K. S. G.

Sugar Technology Research

To carry out research in the different branches of sugar technology, the Imperial Institute of Sugar Technology at Cawnpore was started by the Government of India on October 1, 1936. It aids factories by advising on matters relating to improvements in working of plant, improvements in manufacturing processes and technical control of manufacturing operations. The Institute also trains students in all branches of sugar technology and provides short refresher courses for technical employees of sugar factories.

The sugar research and testing station at Bilari, the bureau of sugar standards, an experimental sugar factory, a workshop, sugar engineering and chemical engineering laboratories and a research scheme for the manufacture of cattle feed from molasses are some of the constituent subjects of the Institute. A sugar trade information service is also under the control of the director.

Of the research schemes for utilising molasses, cattle feed containing molasses are under preparation which can economically replace common fodders. Road-surfacing compositions containing molasses seem to be satisfactory. Experiments on the fermentation of molasses to butyl alcohol, acetone and acetic acid and on the preparation of yeast are showing the practical possibility of developing these into paying industries. The proper disposal of sugar factory effluents is of the greatest importance in order to safeguard the health of the workers and of residents in adjoining areas. A simple and satisfactory method of disposing of effluents has been evolved in the Institute, based on which large-scale plants have been erected.

Electricity in Indian Mines

INCREASED use is being made of electrical and mechanical appliances in Indian mines. The number of coal mines using electrical energy was 144 in 1939 as compared with 136 and 124 in the two previous years and the aggregate horse-power employed at coal mines increased from 98,077 in 1938 to 1,04,000 in 1939, an increase of 6.05 per cent. During the year electrical plant was installed in seven mines, and of mines using electricity one was reopened. The number of coal cutting machines used was 203 in 1939, as compared with 186 in 1938 and 140 in 1937. All the machines were electrically operated and were employed in 72 mines. Besides coal cutting machines six pneumatic picks worked by compressed air were in use in one mine. The total area undercut was 10,816,000 square feet as compared to 8,827,000 square feet in 1938.

Besides, electricity used in 22 metalliferous mines aggregated 8,107 h.p. as against 7,751 h.p. in the previous year.

Glass and Optical Industry

KAMALESH RAY

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THE story of the discovery of glass is lost in the mists of antiquity. The well-known Phoenician story is no longer believed as this people is now known to have entered the arena of history after 1500 B.C., while pieces of glass have been found in the lowest strata of excavations (dated c. 3000 B.C.) at the sites of ancient Egyptian and Babylonian civilisations that have hitherto been dug up. Glass is now supposed to have been melted first about 7000 B.C. Flinders Petrie says that art of glazing on stone and stoneware was known in Egypt as early as 12,000 B.C. (Badarian culture). Early glasses were almost exclusively used for ornamental and decorative purpose, either in the form of beads or for figuring vases and cups, or for making mosaic figures by glazing with quartz powder as base. Glass has been found associated with ancient civilisation in Egypt, Ur (Lower Mesopotamia), Syria, India and China. Primitive people have also been found using glasses of volcanic and other natural origin as valuable jewels.

Some of the Chinese glasses of antiquity (about 550 B.C.) have been found to contain barium and lead (flint glass). These have densities from 3.25 to 5.25, and appear to have had refractive index higher than many of the flint glasses manufactured nowadays (see table VIIa). Such dense glasses have small critical angle and give high surface-reflection, and it appears that this was the reason why the Chinese glass-ornaments and glass-gems were so prized in those days. Modern imitation jewels are also made out of heavy lead glass for the same reason. But the Egyptian ones, although mostly beautifully coloured, were not so glittering owing to their low refractive index.

Early glass industry was, however, confined to melting and casting alone, glass-blowing appears to have been unknown till the beginning of the Christian era. Glass blowing appears to have been discovered in Alexandria, the home of early science, about the first century B.C. It created a revolution in the industrial world.

COMPOSITION OF GLASS

Glass approximates to the formula $\text{Na}_2\text{O}, \text{CaO}, 6\text{SiO}_2$, with much variation in composition, and is obtained by melting together sand, soda and lime in different proportions. Ordinary glasses have nearly 70% sand (silica), 15% soda and 15% lime. It also usually contains other metallic oxides to give specific properties or colours. Nature produces glass by volcanic or igneous action, sometimes a lightning may cause glass formation. Such natural glasses were very much valued as gems. The volcanic glass from Mt. Vesuvius was found on analysis to contain 53% silica, 15% soda, 3% lime, 20% alumina, 5% iron oxide (giving deep green colour) and the rest 4% other minerals. Another Mexican natural glass of volcanic origin showed 74% silica, 9% soda, $\frac{1}{3}\%$ lime, $12\frac{1}{4}\%$ alumina, etc. A sample of natural glass from African desert formed by lightning striking on sand naturally contained very high proportion of silica. Analysis showed that it contained 97 $\frac{1}{2}\%$ silica, $\frac{1}{3}\%$ soda, $\frac{1}{3}\%$ lime, $1\frac{1}{2}\%$ alumina and $\frac{1}{3}\%$ iron oxide.

GLASS CONSUMPTION IN INDIA

Ancient commercial glasses were soft, that is to say, easier to melt and work, as they contained much soda which is a good flux for melting silica or sand. Ferozabad has been reputed as the centre of glass industry in India from a long time, and even now it produces a large amount of soft glass for making bangles, beads and other ornaments. But India does not produce the fine glass which is so widely used in the modern civilised countries (See tables I and II on the next page).

MODERN GLASS TECHNOLOGY

The present century has seen a large variety of glasses to suit the ever-increasing demands of modern civilised life. In this respect, the glass industry in India may still be said to be in a state of infancy. Most of the industrial works here pro-

duce glass of poor quality for making blown and pressed articles. They are neither very transparent nor are they properly annealed to resist mechanical and thermal shock.

TABLE I
IMPORT OF GLASSWARE INTO INDIA

Glassware	Values in Lakhs of Rupees.		
	1932-33	1933-34	1934-35
Sheet and Plate	22.95	21.20	23.56
Scientific glassware	1.38	1.16	0.92
Bottles and phials	24.21	20.88	24.57
Funnels, globes and glass parts of lamps	6.67	5.05	5.72
Tableware	5.40	5.26	5.54
Beads and false pearls	12.35	13.42	13.04
Bangles	39.89	27.13	31.07
Other glassware	27.96	26.19	26.32
Total	140.84	120.28	130.75

The latest available figure of total imports however fell to Rs. 125 lakhs in 1938-39.

TABLE II
VALUE OF GLASSWARE MADE IN INDIA, 1935

	Lakhs of Rupees.
Bengal	15.00
United Provinces	12.08
Bombay	4.44
Central Provinces	1.84
Punjab	1.49
Hyderabad	1.00
Madras	0.72
Total	36.57

We are here more interested in the finer types, chiefly, the plate and optical glasses. Unfortunately, in India there is not a single factory that can be said to produce optical glass, and almost the same is the case with plate glass except the Bahjoi Plate Glass Works in U. P. Most of the heavy plate or port glasses are imported from England and Belgium, while, a large part of the window glasses come from Japan. Before the last war, America had little glass industry worth mentioning. But U. S. A. has made wonderful progress since 1919, and now the country stands supreme in glass technology.

From table III we find the value in dollars per tonnage as follows: Germany, 189; Belgium, 106; United Kingdom, 98; U. S. A., 96;

France, 59; and Japan, 40. It is not that all of them manufacture the same quality of glass with different values. Germany produces most of the

TABLE III
ESTIMATED PRODUCTION OF GLASS

Country	Year	Production (000's omitted in both columns)		Number of Establishments	Number of Employees
		Metric Tons	Value \$		
U. S. A.	1935	2948	283,925	213	67,100
United Kingdom	1934	775	76,000	125	43,000
Germany	1935	700	132,000	300	85,000
Japan	1935	500	20,000	696	23,866
France	1937	476	28,000	147	38,000
Belgium	1935	235	25,000	125	28,500

finest optical glasses of the world, and this fetches the highest value. Japan, on the other hand, produces glass chiefly for making ordinary glassware of household use.

The demand for glass goods in modern civilization is very great, and the increasing use in India of these goods has led capitalists to embark on glass factories and very recently some of the firms have taken up the production of laboratory and neutral glasses. One of them (The Scientific Indian Glass Co., Ltd.) has been very successful in Bengal. But nobody has so far manufactured optical glasses. Recently, however, Bahjoi Glass Works, at U. P. has taken up a scheme for experimenting upon optical glasses under the Board of Scientific and Industrial Research.

COMPOSITION OF SPECIAL GLASSES

The chief criterion for the production of fine glass is the purity of raw materials to be used in the batch. Among other impurities, iron (in the form of oxides) in the sand is very common and objectionable. This impurity imparts bluish green colour which is observed in the window panes. The colour is recognisable even when it is present in as small a proportion as 0.03 per cent. For making the crystal-clear tableware the blue tint makes it less attractive and less valuable. From the optical consideration, the iron cuts down the transparency which is a great factor among other optical requirements. Ordinary window plate has a transparency (measured usually with 2 mm. thickness) of about 90% against 99% for optical glass which contains less than 0.02% of Fe_2O_3 . Some of the

modern plate glasses have transparency approaching that of optical glass, since these have very small iron content of the sand used.

The percentage composition given in the table IV are as calculated from the raw materials entering into the batch. The chemicals are used in different forms, such as, Na_2O is obtained from soda ash Na_2CO_3 , K_2O from pearl ash K_2CO_3 or from nitrate KNO_3 , B_2O_3 from borax and boric acid, PbO from red lead etc. The composition however is found to alter slightly when the final glass is analysed. But the initial composition is always a guide for the manufacture.

TABLE IV
COMPOSITION OF SOME PLATE AND OTHER GLASSES

	SiO_2	Na_2O	MgO	CaO	Al_2O_3	FeO	K_2O
American window	71.82	14.27	3.31	8.9	1.40	0.07	...
American window	72.26	14.01	...	13.34	1.42	...	...
French window	69.65	15.22	...	13.31	1.82	...	...
German window	72.68	13.25	0.26	12.76	1.06	...	...
Indian blown ware (average)	74.00	17.40	...	6.80	...	...	1.4
Indian bangle glass	73.50	19.50	...	7.00	...	...	...

The iron as impurity may be present in two forms, FeO and Fe_2O_3 . The limit for ultra-violet transmission is determined by the content of ferrous iron giving bluish green colour which is common in window glasses, and it stops all light shorter than 3130\AA . On the other hand, ferric iron imparts yellow tint and has strong absorption in the near infra-red at about $10,000\text{\AA}$. The proportion of the ferric iron to ferrous increases with the presence of arsenic or antimony oxide. The colours due to iron content of sand may be masked by a decoloriser, such as manganese or selenium, but this does not increase the total transparency in any way.

USEFULNESS OF PLATE GLASS

The quality of modern plate glass is excellent and is quite good even in the optical sense. In fact, the modern plates are superior to the pre-war optical glasses, and may well be employed for making optical instruments of average quality. Some of the field telescopes have greenish glass for their object lens (usually the double convex crown component) which protect the eye from the glare of the sun and open sky. The Crookes' spectacle glass (introduced by Sir William Crookes) contains iron and cerium, which filter off the injurious infra-red and ultra-violet. The A-grade has 89 per cent and B-grade

69 per cent of transmission (2 mm. thickness) in the visible light. The lower transmission of plate glass (90% against 99% for "white" spectacle) does not matter, provided that the plate is found to be free from strain when examined between crossed Nicols.

Opera glass, eyepiece, condensing lens, reading glass, class-experiment lenses, etc., can be easily made with modern plate glasses of the finer variety. Plate glasses can be used very well for reflecting systems like small telescopic mirror, arc light reflector, ophthalmoscope mirror, optical test plate etc. The plate glasses are usually so evenly annealed that telescope mirrors or optical flats are seldom found developing defective zones due to warping of the glass even after a long time.

PROCESS OF MANUFACTURE

Plate glass is sometimes made in pots, in which case the melt is poured on an iron casting table for rolling into sheets, or it is directly flown into large power-driven rollers through which the plate flows on to a moving table beneath. But, for commercial efficiency, most plate glass today is drawn in continuous sheet directly from a tank, and it passes down the annealing tunnel (lehr) of proper temperature gradient.

The best quality optical glasses are invariably made in pots (capacity $\frac{1}{2}$ —1 ton), a new pot being used for each melt. Optical glasses require various essential features such as transparency, homogeneity, freedom from strain, chemical stability, various refrangibilities and dispersions, etc. Among these, the transparency, as already mentioned, depends upon the purity of the ingredients which is not difficult to attain. The thorough admixture of the batch-materials ensures the homogeneity. Stirring of the melt is also necessary, but the wall of the pot is a sure source of inhomogeneity. For this reason the stirring of the melt is never carried to beyond two or three inches of the wall. If the glass is poured from the pot for rolling, the streaks of inhomogeneity (varied refractive indices) appear. The best quality is obtained by allowing the pot to cool slowly and finally collecting the chunks, after breaking the pot, from the middle regions. This increases the cost of production, but the quality so obtained is excellent. The chunks are then sawed into small slabs or suitable blanks for optical grinding.

The strain in glass is removed or reduced to a minimum by the process of annealing. The amount of strain is measured by the birefringence or separation of the ordinary and extraordinary rays per centimetre of the glass. In optical glasses the

birefringence should not exceed $5 \text{ m}\mu$ ($1 \text{ m}\mu = 10^{-7} \text{ cm}$) per cm. of path in the glass. On an average, for most glasses, a load or stress of 1 kg. per sq. cm. ($=14.2 \text{ lbs. per sq. in.}$) produces a birefringence of about $0.3 \text{ m}\mu$. So that a birefringence of $5 \text{ m}\mu$ corresponds to a stress of about 16.7 kg/cm^2 or 237 lb/in^2 .

The annealing temperature is defined as that at which the strain will decrease from infinity to $2.5 \text{ m}\mu$ in two minutes. It has been found that the amount of initial strain does not affect the time at such condition.

TABLE V
ANNEALING AND SOFTENING TEMPERATURES

Glass	Annealing °C	Softening °C
Borosilicate Crown (composition, Table VIII) ...	495	565
Crown (approx. Table VIII) ...	573	650
Ordinary Silicate Flint (Table VIII) ...	410	490

The chemical stability of glass is achieved by the determination of proper proportion of the ingredients. In general, the most effective flux for silica (in the form of sand) is soda, Na_2CO_3 . But too much of soda makes the glass chemically less stable. Lime (CaO) on the other hand makes it more durable, but high proportion of lime results in a glass hard to melt, and leads to devitrification (separation of crystalline compounds in the glass). If devitrification takes place, the melt is ruined. Devitrification is the chief factor which limits the composition range of practical glasses, and if there be any error in composition or technique, this takes place quickly.

A small proportion of alumina (Al_2O_3) removes certain difficulties. It gives greater chemical

durability (see Table VI), lowers the co-efficient of thermal expansion (Table IX) and ensures greater freedom from devitrification. Potash has also somewhat similar effect, while a small proportion of barium and boric oxide controls the devitrification trouble to a considerable extent. Arsenic is used for refining and removing 'seeds' (small bubbles) from the glass.

TABLE VI
RESISTANT GLASSES

	SiO_2	B_2O_3	Na_2O	K_2O	MgO	CaO	Al_2O_3	ZnO	Fe_2O_3
Pyrex ..	80.5	12.9	3.08	4.0	...	...	2.2	...	...
Jena Gerate ..	75.3	7.6	5.7	0.8	...	1.1	6.2	...	...
Jena Gerate breaker ..	64.7	10.9	7.5	0.37	0.21	0.63	4.2	10.9	0.25
Jena Supremax ..	57.4	23.6	1.9	0.5	8.7	4.7	3.2	...	...
Resista ..	75.3	15.8	3.4	1.0	...	1.3	2.5	...	...

OPTICAL AND OTHER PROPERTIES OF GLASS

The versatile optical properties of glasses are secured by the different proportions of the ingredients. Borosilicate glasses have low refractive index and dispersion. Crown glass, which is essentially of plate glass variety, possesses these values to a greater extent than the borosilicate, but to a lesser extent than those of flint glass which has the highest index and dispersion. Flint glass owes its high index and dispersion to its high lead (PbO) content which, on the other hand, lowers the transmission, especially on the short wave side.

Apart from actual absorption of light in the flint glass, the surface reflection is also greater due to its high refractive index. This is why lead glass is preferred in the art of glazing and in making tableware, and is also used for making imitation stones. For normal incidence, the proportion of reflected light is given by $R = \{(n-1)/(n+1)\}^2$, or in percentage, $R\% = 100 \{(n-1)/(n+1)\}^2$, where n =refractive index.

TABLE VII (a)
OPTICAL PROPERTIES

Factory number	Glass	Density	nD	Mean dispersion $n_F - n_C$	ν	Partial Dispersions		
						C—D	D—F	F—G'
3484	Borosilicate Crown ...	2.40	1.4980	.00763	65.3	.00227	.00536	.00425
B1664	Do. ...	2.53	1.5164	.00808	63.9	.00245	.00663	.00458
B0061	Crown ...	2.44	1.5002	.00822	60.9	.00242	.00580	.00564
605	Hard Crown ...	2.49	1.5175	.00856	60.5	.00254	.00602	.00484
3463	Light Barium Crown ...	2.90	1.5407	.00910	59.4	.00268	.00642	.00517
4277	Telescope Flint ...	2.67	1.5237	.01003	52.2	.00295	.00708	.00577
C1736	Dense Flint ...	3.59	1.6173	.01691	36.5	.00486	.01205	.01031
381	Do. ...	3.63	1.6214	.01722	36.1	.00491	.01231	.01041
4141	Extra Dense Flint ...	4.47	1.7167	.02430	29.5	.00696	.01744	.01511

TABLE VII (b)
COMPOSITION OF GLASSES IN TABLE VII (a)

Factory Number	Glass	SiO ₂	B ₂ O ₃	Na ₂ O	K ₂ O	CaO	BaO	ZnO	PbO	Al ₂ O ₃	As ₂ O ₃	Sb ₂ O ₃
3484	B.S.C.	59.5	21.5	...	14.4	0.3	...	2.3	...	1.9	0.1	...
B1664	B.S.C.	70.1	10.7	16.02	...	...	2.84	...	...	...	...	0.34
B0061	C.	73.63	...	19.91	...	4.76	...	...	...	0.64	0.36	...
605	H.C.	69.6	...	...	18.4	11.5	...	...	...	0.3	0.2	...
3463	L.B.C.	57.1	1.8	...	13.7	0.3	26.9	...	...	0.2	0.1	...
4277	T.F.	52.4	18.3	2.3	4.3	0.3	...	...	...	1.9	0.1	20.4
C1736	D.F.	46.15	...	8.4	...	0.52	...	...	47.7	...	0.23	...
361	D.F.	46.3	...	5.0	1.1	0.3	...	...	47.0	0.2	0.1	...
4141	E.D.F.	25.1	...	...	2.8	0.1	...	...	61.8	0.1	...	...

Glases B1664, B0061 and C1736 are manufactured by the French company Para-Mantois, and the rest by the Chance Brothers & Co., Ltd., England. B0061 contains also 0.7 per cent. of fluorine. C, D, F, G' lines are respectively 6563, 5863, 4861 and

$$4341 \text{ A. } \nu = \frac{nD - 1}{nF - nC}$$

The following table gives the composition of some of the glasses made by Schott and Gen. of Jena.

TABLE VIII

Glass	SiO ₂	B ₂ O ₃	Na ₂ O	K ₂ O	CaO	ZnO	PbO	Al ₂ O ₃
Borosilicate								
Crown ...	68.1	3.5	5.0	...	...	...	...	5
Crown ...	74.6	...	9.0	11.0	5.0	...	43.8	...
Silicate flint	46.6	...	1.5	7.8	...	...	46.6	...
Silicate flint	44.6	...	0.5	8.0	...	...	...	...
Borosilicate								
Thermometer	72.0	2.0	11.0	...	...	...	...	5.0
Normal								
Thermometer	67.3	2.0	14.0	...	7.0	7.0	...	2.5

Borosilicate thermometer glass has quite low thermal expansion (6×10^{-6} cm. per °C), but the 'Normal' (8×10^{-6}) is more extensively used. The expensive behaviour of the latter has been studied thoroughly by Keesom and others at the Leiden University for low temperature work.

Colour, as already noted, is particularly avoided in optical glass, except for some special purpose, such as, spectroscopic filters, photographic sky filter, Crookes' spectacle glass, etc. The transmission characteristics of a glass are due to the metallic oxides in the glass, such as those of copper (giving blue colour), cobalt (violet blue), nickel (brown), manganese (purple), iron (green) etc. These show strong and broad absorption bands, while rare earth oxides give us narrow bands towards

the ultra-violet side of the spectrum. Cerium imparts pale amber tint to the glass, and is used to

TABLE IX
CO-EFFICIENT OF THERMAL EXPANSION

Glass	Co-efficient per deg. C	Composition
Pyrex ...	3.5×10^{-5}	Table IV.
Jena Gerate beaker ...	5.6	...
B. S. Thermometer ...	6.0	Table VI.
Normal ...	8.0	"
B.S.C. optical ...	9.0	...
D.F. ($n_D = 1.62$) ...	9.7	...
Plate Glass ...	10.0	Average. See
Crown Optical ...	10.3	Tables II and V.
Commercial Glass ...	10.5	...

make the glare proof spectacles commercially known as the Crookes' glasses. We have in Travancore (south India) monazite sands* containing a high proportion of cerium, thorium etc., which is exported to other countries in large quantities every year. The alantite deposits near Ranchi and Purulia also contain high percentage of cerium.

DEMAND AND SCOPE FOR OPTICAL INDUSTRY IN INDIA

It appears that the raw materials necessary to make varieties of optical glasses are available in this country. But only two of them (Crown and Flint approximately like Nos. 605 and 361 of Table VII) may make large varieties of achromatic instruments. An optical factory can very well run with these two types only.

Optical glass is one of the key materials of civilisation. The demand for optical instruments is ever increasing, and is indispensable in the scientific

* See article Thorium from Monazite Sands in SCIENCE AND CULTURE, '99, 1940-41.

world. This is now recognised as one of the essential elements in modern warfare. India has no optical industry of her own and she has to indent optical instruments at exorbitant price from foreign countries.

Regarding the manufacture of optical instruments, experience will show that the construction of the optical parts (lens, prism etc.) are far easier than to mount them up in the form of a complete instrument. A few examples may be picked up in order to support this statement.

Let us consider, first, the construction of a photographic camera. A pair of achromatic doublets will make either a 'Petzval' or a 'Rectilinear' photographic system, opening up to $f/4.5$. This will make quite a rapid camera, and the price will run to some three figures according to the size, shutter, stop-diaphragm, release, film seat and other features. And these details mean the maintenance of a good mechanical workshop equipped with precision machines. There is little trouble about the lenses, for, when the computation is complete in paper and pen, they can be got ground up perfectly well by ordinary cheap labour.

The usual achromatic lenses and prisms for binoculars and field glasses can be made in lots by arranging the blanks on a suitable large runner. The casing and the fitting parts have got to be cast and machined in complete details.

The larger telescopic lens, even when it is only a doublet achromatic, sells at exceedingly high price. The price of a well-corrected 6-inch achromatic $f/16$ telescope objective (residual spectrum spreading not more than $1.5 \times 10^{-3}f$) goes above a thousand. But a detailed equatorial mounting for the telescope is more difficult to make and is more costly too. In this respect, microscopes of low and medium powers are easier to make, and this instrument has probably a wider market.

Excepting spectacles, other optical instruments have more or less elaborate mechanical parts. Mechanical workmanship, however, can be obtained here and the manufacture of optical instruments can be made a successful venture.*

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MEDICINE & PUBLIC HEALTH

Stilbestrol-Induced Gynaecomastia in the Male

NATURALLY occurring oestrogenic substances or oestrogens stimulate the growth of certain tissues, one of which is the breast tissue. When administered in sufficient quantities, it has been proved to depress certain functions of the anterior lobe of the pituitary gland, specially in the production of growth and gonadotropic hormones. Dunn (*Am. J. Obst. & Gynec.*, 30, 186, 1935) produced development of breast in males and immature females by injection of natural oestrogenic substances. Dunn has recently studied (*J. A. M. A.*, 115, 2263, 1940) the action of the synthetic oestrogen, stilbestrol, in a male sexual criminal aged 27, convicted with a seven year history of repeated sexual offences against minor females. There was abnormally high urinary excretion of androsterone (testes hormone) and the gonadotropic principle of the urine of pregnant women. The individual had an abnormally large penis and oversize testes. All these suggested an anterior pituitary gonadotropic hyperactivity. The individual was given 5 mg. stilbestrol daily for sixty days and on alternate days for another period of thirty-six days. Total amount of stilbestrol administered was 480 mg. At the end of ninety-six days it was observed that a hard firm mass, 6 cm. in diameter and 2.5 cm. thick, had developed under the nipple in both the breasts. Stilbestrol also definitely inhibited the hyper-sexual state. The penis and testes were reduced to two-thirds of the previous size. No libido was found and on masturbation no seminal fluid was ejaculated. No toxic manifestations were observed even after the administration of high doses of stilbestrol. This shows that this synthetic oestrogen is as active as the natural oestrogens and may be substituted for it.

S. B.

Alleged Hepatotoxic Action of Stilbestrol

STILBESTROL is now being used in place of natural oestrogens because it is as potent as the natural substance and it can be administered per mouth. Most authors however have observed that patients usually

suffer from gastrointestinal distress, principally nausea after taking stilbestrol. Buxton *et al* (*J. A. M. A.*, 113, 2318, 1939), MacBryde *et al* (*J. A. M. A.*, 113, 2320) and Shorr *et al* (*J. A. M. A.*, 113, 2312, 1939) have observed skin eruptions, lassitude, headache, and psychosis in the patients. They are also of opinion that this drug has produced liver damage in stilbestrol treated patients. Freed *et al* (*J. A. M. A.*, 115, 2264, 1940) studied the effect of stilbestrol in menopausal women some of whom showed liver dysfunction. No toxic manifestation of stilbestrol in livers of these women receiving 5 to 10 mg. stilbestrol daily was observed. When tested in rats or dogs no cellular damage in liver was observed even when a large quantity of the drug was administered. No toxic action was observed in a case convalescing from acute hepatitis. Gastro-intestinal disturbances were observed in 20 per cent of the cases studied.

S. B.

Snake Venom in Coronary Thrombosis

To give relief to a case of coronary thrombosis the only useful drug which we possess in our armamentarium is morphine or morphine derivatives. Morphine is a habit-forming drug and the continued use of this drug may lead to this danger of habituation. Macht (*Ann. Int. Med.*, 11, 1824, 1938; Macht *et al*, *Proc. Soc. Exp. Biol. & Med.*, 41, 418, 1939) studied the effect of cobra venom in certain painful conditions and suggested its use in the relief of those suffering from repeated attacks of cardiac pain. He studied the physiologic, pharmacologic and psychologic effect of cobra venom (*Proc. Nat. Acad. Sci.*, 22, 61, 1936). The drug acts upon the higher nerve centres to produce its analgesic effect and unlike morphine it is neither habit-forming nor produces mental depression. Recently Parsonnet *et al* (*Am. J. Med. Sci.*, 200, 581, 1940) successfully treated five cases of coronary thrombosis with cobra venom. Pain was relieved with adequate doses of cobra venom and no untoward symptoms were observed.

S. B.

Adding Nutritive Qualities to Flour

To avert any calamity due to food shortage and blockade the British government has planned to fortify white flour with crystalline thiamin. The British Government has thus recognised the necessity of supplying vitamins as well as bulk food for whole population although Germany, according to Professor Drummond, had started to do it earlier. It is reported that the American manufacturers have voluntarily adopted such a plan. There are other chemical deficiencies rampant among our people. They result from living on refined fats, carbohydrates, milled cereals, etc. They can be made up by very small amounts of riboflavin and nicotinic acid.

When the Millers' National Federation recommended some time back vitamin flour to correct nutritional deficiencies of the American people, the director of research for General Mills reluctantly said that this great public health step was impractical, because of the prohibitive cost of pure thiamin.

The production of the first gram of pure thiamin, about one thirtieth of an ounce—occurred only four years ago, and was a terrifically complicated chemical process. The first commercially quoted price of this key life chemical was \$700 a gram. But, just as the millers rose to the challenge of the physicians, so in turn the chemical industry rose to the challenge of the millers. A gram is now to be had for 98 cents. And when chemical industry swings into mass production, it is predicted that the cost will drop to 12 cents. Taken in tiny daily doses, a gram is an average person's supply of thiamin for a whole year. Nicotinic acid however presents no price problem. In three or four months, probably riboflavin will also be produced in quantity. Eventually, when industry goes into mass production, these three life chemicals will be added to flour at no additional cost to the consumer.

The supercharged flour will not only restore to bread the chemicals hitherto milled out, but will carry an extra ration to help allay our hidden vitamin-hunger. *The Reader's Digest* writes that bread will again become, in truth, the staff of life; and will correct gradually the systems of chronic famine.

J. B. G.

Scientific Board for Calcutta Corporation

On the occasion of the opening of the Central Analytical Laboratory of Calcutta Corporation (see

page 472 of the February 1941 issue of *SCIENCE AND CULTURE*) the Mayor made a detailed analysis of the various problems confronting the city councillors and suggested the imperative necessity of a number of scientific advisory boards. We are glad to report that pursuant to a resolution of the Corporation a tentative scheme has been prepared now regarding the organisation of a Scientific and Technical Advisory Board with a number of constituent committees. The suggestion put forward and recommendations made by these committees will be co-ordinated by this Board, which will frame final proposals for consideration by the Corporation.

The Mayor points out that proposed personnel of the Board and of the committees have been drawn from younger men in the scientific sphere of Calcutta with a view to utilising more of their energy and time in the day-to-day work of these bodies. Besides the existing Mosquito Control Committee and Water Supply Advisory Board, seven committees have been proposed. These are (1) committee for the care of the sick to go into the question of (i) hospital accommodation in Calcutta, (ii) isolation in infectious diseases, (iii) outdoor treatment, and (iv) provision of diagnostic laboratory service for medical treatment; (2) prevention committee to consider (i) the whole system of preventive inoculation in the city, and (ii) suggest measures for its improvement and expansion; (3) maternity and child-welfare committee to deal with the question of maternity and child-welfare of the city in all aspects; (4) sanitation committee to deal with and suggest measures of improvement concerning (i) the question of keeping streets clean, (ii) the system of collection, transport and disposal of refuse, (iii) the problem of drainage and river pollution, (iv) the question of bustees and (v) suggest all measures concerning these; (5) physical fitness and recreation committee to deal with the question of improving and using the public parks and the maidan for purposes of mass drills, gymnastics, etc., and to suggest measures for the promotion of the health and joy of the children and school- and college-going population; (6) food and nutrition committee to deal with (i) the supply, preservation, transport and distribution of pure foodstuffs in the city, (ii) the effective prevention of adulteration of any kind and (iii) the possibility of running community kitchens and community restaurants in accordance with modern nutrition principles both for school children and for the public; (7) education committee to deal with the question of (i) providing educational facilities to the poorer children, (ii) suggesting means of improving the standard of education, and (iii) suggesting means of providing technical and vocational education, particularly through evening institutions.

Conquest of Kala-azar

USE OF ANTIMONY IN THE TREATMENT OF KALA-AZAR

IN the Middle Ages (15th—17th century) the element antimony (Lat. Stibium) came to have a wide reputation as a universal panacea for all kinds of diseases. Probably the reputation had its origin on genuine observations, but was pressed too far. Wine cups made of antimony had a considerable vogue. When wine was left in there for sometime, the tartar in the wine apparently combined with the oxide in the cup so as to form tartar emetic (a double salt of tartaric acid with potassium and antimony).



ANTIMONY CUP

The illustration shows such a cup with the German inscription "Thou art a wonder of nature and all men's certain cure". Indiscriminate use of such wine cups by monks sometimes caused mysterious diseases very often ending fatally. It is thought that from the high mortality amongst monks, the element came to be known as 'Antimonk', later corrupted to Antimony. Before the introduction of antimony treatment widely different methods of treatment of kala-azar were tried from time to time but without any success.* As a matter of fact, none of the

remedies suggested could reduce the death rate from the disease to less than 98 per cent., and the attempts were merely gropings in the dark. Modern science came to the aid of the physician only in 1915.

Turning to modern times, a Brazilian doctor, Vianna, reported in 1913 to have cured the South American form of cutaneous and mucous leishmaniasis by injecting tartar emetic intravenously. This disease appeared in the form of ulceration of the skin of mucous membrane due to parasites allied to Leishman-Donovan bodies, which are the causative organisms of kala-azar. Di Cristina and Caronia of Sicily also recorded the successful use of tartar emetic in infantile kala-azar of the Mediterranean basin (1915). A little later Rogers in Calcutta (1915) obtained favourable results in a number of kala-azar cases with intravenous injection of tartar emetic. Rogers claimed that he had found out the remedy without previous knowledge of the work of the Brazilian and Italian doctors.

Tartar emetic administered intravenously undoubtedly proved to be more successful than other drugs but extended use by Rogers and other physicians revealed certain very serious defects. Let us describe the defects of the tartar emetic treatment, in the words of Rogers himself.

"Solutions of potassium or sodium antimonyl tartrate do not keep well especially in a tropical climate, and the salts are readily decomposed, especially by bacterial contamination when very toxic substances appear to be produced and form a fine precipitate."

Further, he "recorded accidents resulting from solutions sterilized in the autoclave in the hot, humid rainy season in Calcutta, through repeated punctures in the rubber caps in taking up the dose. Very serious toxic symptoms appeared within a few hours, and even terminated fatally".

Napier of Calcutta School of Tropical Medicine (1927) also noted that among other complications produced by tartar emetic injections may be mentioned coughing, vomiting, pneumonia and lung complications, aggravation of kidney and bowel complications, joint pains, eruptions, very marked slowing of the heart and very sharp reactionary rise of temperature.

In addition to the above observations of individual observers, mass observations on the harmful effects of potassium and sodium antimonyl tartrate

* For earlier articles and an account of these treatments see *SCIENCE AND CULTURE*, Vol. 5, Pp. 543, 622, 1939-40.

treatment are also available. The province of Assam was widely affected by kala-azar and the provincial Government made large-scale experiments with various drugs claiming to be useful remedies of the disease. The following observations of Major Murison, director of public health, Assam, regarding potassium and sodium antimonyl tartrate, therefore deserves attention.

"The treatment of the disease in Assam with tartar emetic began in 1919, when only a comparatively small number of cases were treated. It was soon realised that this drug was not without its dangers and it was soon replaced by sodium antimonyl tartrate, which was found much safer and gave much more satisfactory results".

The sodium antimonyl tartrate referred to above was first introduced by Dr (now Sir) U. N. Brahmachari, then teacher of medicine in the Campbell Medical School, Calcutta. But though in certain respects, it proved better than the potassium salt, it had its own defects. These are described vividly by Murison:

"Although treatment with sodium antimonyl tartrate has been very successful, it has the disadvantage of being long and tedious. Treatment is therefore difficult to enforce, as patients who have been completely incapacitated by the disease, improve so considerably after a few injections that they discontinue treatment or attend very irregularly. This irregularity makes it very difficult to effect complete cures. In spite of the regulations in force under the Epidemic Diseases Act to compel patients to undergo a complete course of treatment the campaign against kala-azar in Assam was greatly handicapped by the large number of patients who are stopping treatment".

"It was felt that the above difficulties would be still further overcome if some drug could be introduced which was not only as efficacious as sodium antimonyl tartrate but took a much shorter time to effect a cure".

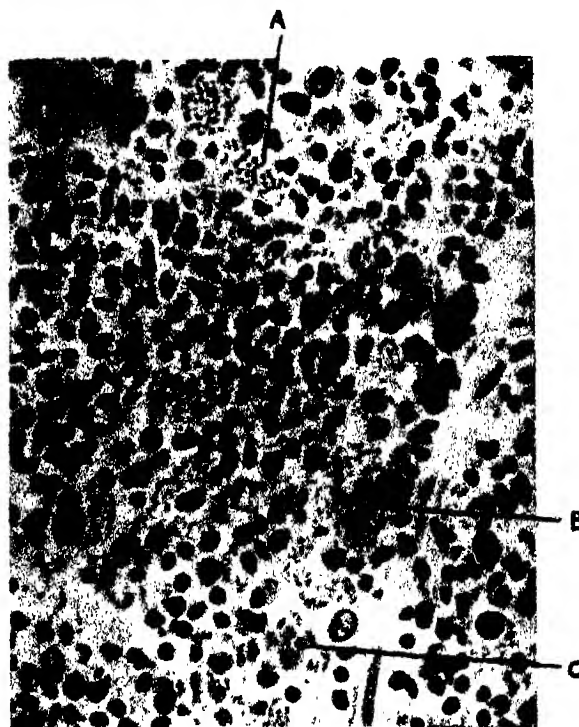
BRAHMACHARI'S CHEMO-THERAPEUTICAL RESEARCHES

This observation would convince anybody that in spite of the efficacy of potassium or sodium antimonyl tartrate there were difficulties in their mass application against kala-azar as has been done in recent years. Even until two centuries ago use of antimony remedies was banned by the medical faculties of Paris and Heidelberg on account of many evil effects. Probably history would have repeated itself and antimony treatment of kala-azar would have fallen into disuse if more extended chemo-therapeutical researches, culminating in the discovery of organic antimony compounds producing non-toxic effects, were not undertaken. We shall now give a short account of these chemo-therapeutical researches. A large portion of these chemo-therapeutical researches was done by Brahmachari under great difficulties.

In carrying out the self-imposed work, Brahmachari showed a single-minded devotion to a problem followed by dogged tenacity. No proper laboratory facilities were available to him at the time and he had to carry on his researches in a small room without a water tap or gas point and lighted by a kerosene lamp at night and often in the midst of troubles and difficulties from many quarters.

METALLIC ANTIMONY IN A STATE OF FINE SUB-DIVISION AND COLLOIDAL ANTIMONY

Brahmachari first tried inorganic antimonials in the treatment of kala-azar in the hospital attached to Campbell Medical School. Some success attended the use of metallic antimony in a state of fine sub-division (1915) and of colloidal metallic antimony (1916 a).



PHOTOMICROGRAPH OF SPLEEN OF A MOUSE INFECTED WITH *Leishmania-Donovani* FORTY-EIGHT HOURS AFTER INTRAVENOUS INJECTION OF METALLIC ANTIMONY.

- A. Cell containing leishmania, but no particles of antimony.
- B. Cell with faintly stained cytoplasm containing leishmania and a few particles of antimony.
- C. Cell containing coarse granules of antimony and leishmania, some of which appear to be degenerated.

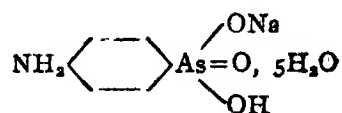
(Reproduced from a paper by Brahmachari and co-workers published in the *Transactions of the Royal Society of Tropical Medicine and Hygiene*, Vol. XXIII, No. 6, April, 1930.)

The efficacy of metallic antimony was at first established from their effects on patients but later experiments on animals gave more direct proof, it being found that the particles of metallic antimony when injected intravenously were picked up by those cells in the spleen that harboured the parasite of kala-azar and they caused a speedy and complete destruction of the parasites.

The advantage of metallic antimony treatment is that the number of injections necessary to bring about complete cure is only three or four. But the chief disadvantage is the complicated technique of the operation of the injection which stands in the way of large-scale treatment of the disease. The use of colloidal metallic antimony had to be given up as it was observed that it was not very stable. The difficulty of preparing the same on a large scale and the larger number of injections necessary to effect a cure were additional disadvantages. It may be mentioned that colloidal antimony and metallic antimony in a state of fine sub-division were not available in India when Brahmachari first introduced their use here. Brahmachari prepared colloidal antimony by using a special technique (1916 b) and his preparations were found to be more stable than Svedberg's colloidal preparation. Metallic antimony in a fine state of sub-division was also prepared by him in India following an earlier method of Plimmer (1911).

ORGANIC PENTAVALENT ANTIMONIALS

The difficulties and disadvantages of the various methods of antimony treatment of kala-azar induced Brahmachari to turn his attention to the study of organic antimonials. The great success of the organic arsenic compound atoxyl—

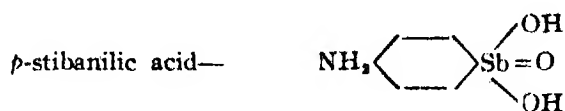


used first by Ehrlich in the treatment of sleeping sickness, gave Brahmachari the inspiration that some similar organic compound of antimony might be found which would prove to be an ideal cure for kala-azar.

The reasons for this belief were :

- (i) the fact early noted by Manson that the kala-azar parasite was similar to that of sleeping sickness, and secondly
- (ii) that metallic antimony undoubtedly was poison to the kala-azar parasites.

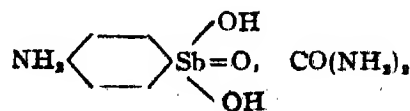
So Brahmachari argued that an antimony compound similar in constitution to atoxyl obtained by replacing arsenic in atoxyl with antimony would be a specific against kala-azar. He considered the process to be quite feasible as both arsenic and antimony belong to the same group in the Periodic Table. Preliminary observations on the preparation and therapeutic properties of such a compound, viz., sodium salt of *p*-stibanilic acid which is atoxyl with arsenic replaced by antimony, was first communicated by Brahmachari in 1919 to the Indian Research Fund Association. They gave him financial aid to carry on a large number of experiments with salts of



It is to be noted that this acid is similar to arsanilic acid, the sodium salt of which is atoxyl. Arsenic has been replaced by antimony. Most of these salts when used for intramuscular injection were found to be good specifics against kala-azar but the injections proved to be too painful.

DISCOVERY OF UREA STIBAMINE

Attempts were therefore made to synthesize a salt which would produce no painful effect. He had to carry on a large number of experiments with various salts and ultimately led by the knowledge that the presence of urea in certain salts, e.g., in quinine urea, produce anaesthetic properties, he first synthesized the urea salt in 1920. This is the story of the discovery of UREA STIBAMINE,—



the urea salt of *p*-stibanilic acid. The discovery is not certainly accidental, as some people seem to think nor was it so easy as might appear from the short description above. If a record of the large number of experiments carried out by Brahmachari between the years 1915-1921 were kept, the drug finally discovered might have been described by a figure of three digits following the popular German practice. The curious reader will find an account of some of these experiments in Brahmachari's *Kala-azar: Its Treatment* (Butterworth & Co., Calcutta, 1917 ; 1920).

THERAPEUTICAL OBSERVATIONS ON UREA STIBAMINE TREATMENT

Shortly after the discovery of urea stibamine in 1920, the drug was administered by Brahmachari on patients in the Campbell Medical Hospital, Calcutta. The results justified his expectation, and this encouraged application of the medicine on a mass scale by Brahmachari himself and other medical men. Actual records of a large number of cases in the wards of the Calcutta Medical College Hospitals under different physicians in 1923 showed that the disease was radically cured in three weeks after injection of 1.5 gms. of urea stibamine.

The most exhaustive observations were made by Major Shortt (1923) of the Indian Medical Service, Director, Pasteur Institute, Assam, and until very recently professor of protozoology in the London School of Tropical Medicine, and Dr R. Sen. Their observations are quoted more or less in full:

- (a) *Tolerance to the drug.* Even in those patients to whom the largest total quantity of urea stibamine was exhibited no symptoms of intolerance appeared. The largest quantity administered to any case was over 5 gm. The result was in marked contrast to that obtained with the usual antimony salts, where, in a large percentage of cases, symptoms of intolerance, in the form of joint pains, etc., appear after greater or lesser amounts of the particular salt in use.
- (b) *Amount of urea stibamine and time required for sterilization.* This varied with the severity and previous duration of the case. Uncomplicated cases of average severity, especially if of recent origin, were usually cured by 2 gms. of the preparation. Administered on alternate days, this represented a period of about twenty days. A few cases were cured more rapidly. Long standing cases and some with very acute infections of the fulminating type took a longer period and larger total quantities before sterilization was established. Several of the cases were those which had resisted completely treatment by sodium and potassium antimonyl tartrates, yet in no single case did the authors fail to procure sterilization by the use of urea stibamine.
- (c) *Absence of Local irritation.* Urea stibamine injected subcutaneously produced little, if any, local irritation. The importance of this, especially in the treatment of young children, will be realized by anyone who had seen the results of the escape of antimony salts into tissues, when intravenous administration has been attempted unsuccessfully by an unskilled operator. This absence of local irritation raises the question of the possible use of this preparation by subcutaneous or intramuscular administration in special cases. This method is now being given a trial by us, with apparently successful results.

(d) *Rapidity of action.* The amelioration of physical signs and symptoms was more rapid than with the ordinary antimony salts. Reduction of the temperature, diminution in the size of the spleen and generally improved condition of the blood, were more rapidly achieved.

(e) *Action in producing leucocytosis.* In many of the cases urea stibamine had a most beneficial action in producing a rapid improvement in the total leucocyte count. This effect, always a favourable sign in kala-azar, was in many cases most marked, and would alone be a point in its favour.

(f) *Importance of the treatment of cases as early as possible.* The reasons are two-fold:

- (1) Early cases were found to yield more readily and rapidly to treatment, and the affected tissues were able completely to recover their tone and normal functions.
- (2) Very old standing or advanced cases might have their tissues and organs permanently damaged by the disease to such an extent that, even although sterilization as regards parasites was effected, yet their functioning would never be recovered and the duration of life would necessarily be greatly curtailed. The average amount of urea stibamine used per case was found to be 2.6 gms. The average number of injections required for, and the average period occupied in actual treatment with the drug, were found to be twelve injections and thirty-two days respectively. When this is compared with the thirty injections and ninety days usually required for a minimum full course of sodium antimonyl tartrate the advantages of the use of urea stibamine will be obvious, and the more so, as it is apparently capable of sterilizing some of the cases which definitely resist treatment by the usual salts of antimony. The authors concluded that *urea stibamine was by far superior to any other antimonial preparations in general use.* (italics ours).

The same writers (1924), in their final report on the use of urea stibamine in kala-azar noted:

"We consider that the value of urea stibamine has been established as the most efficient drug at present in use for the treatment of Indian Kala-azar. The conclusion is based not only on a series of cases of which we have published the details, but in addition on experience gained in many other cases, both Indian and European, which have passed through our hands or which have been treated with urea stibamine under our direction, a number totalling nearly one hundred cases."

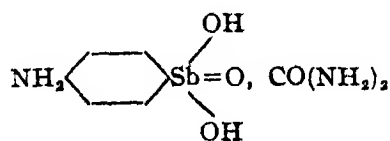
Later on Shortt as director, Kala-azar Commission (1932) stated:

"We found urea stibamine an eminently safe and reliable drug and, in seven years we treated some thousands of cases of kala-azar and saw thousands more treated in treatment centres. The acute fulminating type characteristic of the peak period of an epidemic responds to treatment extraordinarily promptly and with an almost dramatic cessation of fever, diminution in size of the spleen and return to normal condition of health. It may be expected that similar beneficial results will be obtained in other epidemics of the disease."

These observations were confirmed by a large number of medical men both Indian and European, employed in Assam Tea Plantations, and in Government hospitals in Bengal. The use of the medicine has not been confined to India but has been used with success in Greece, France and China.

CONSTITUTION OF UREA STIBAMINE

Contrary to the view held in certain quarters* the preparation of urea stibamine has never been patented and its constitution, as the discoverer has been able to determine, has never been withheld from the public. There has been some controversy regarding the constitution of urea stibamine as happened in the case of atoxyl when it was discovered by Ehrlich. When Brahmachari first discovered the compound he thought its constitution was



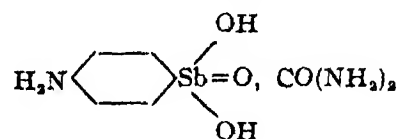
but he did not stop to spend time on the determination of the exact structural formula, as an actual testing of the drug on kala-azar patients was at the time a far more pressing problem. Gray *et al* conducted an extensive investigation on the constitution of urea stibamine in 1931, and the situation has been summarised by him as follows: "The most interesting of the more important derivatives of *p*-amino-phenyl stibinic acid is a material prepared by heating stibanilic acid with urea solution, introduced by Brahmachari (1922) under the name of 'urea stibamine' the nature of which has been the subject of conflicting opinions by other workers as well as by Brahmachari himself." Constant and reproducible results from analysis of urea stibamine.

* See the assertion made by Rogers in *Nature*, 144, 1003, 1930. Rogers had to be reminded of the inaccuracy of his statement and to this he has made so far no reply.

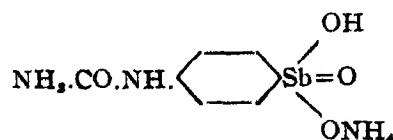
is shown in the accompanying table (the slight discrepancy in the antimony content of samples examined by them being probably due to varying amounts of the protective colloid present):

Carbon	Hydrogen	Nitrogen	Antimony
.....	.....	6.75	44.19
.....	.....	6.77	44.49
20.2	3.0	.....	.....
20.9	2.9	.....	.....
20.5	2.8	.....	.....
20.9	3.0	.....	46.4
21.33	2.67	.....	.....
21.16	2.8	.....	46.8
20.17	2.91	6.47	48.6

It was at first thought (1922) that urea stibamine had the constitution

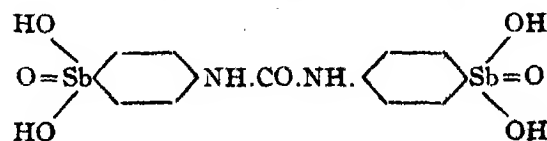


In a later investigation (1924) this was modified to



which was confirmed by Niyogi (1928).

According to Gray *et al* the essential active substance of 'urea stibamine (Brahmachari)' is



(Sym-diphenyl-carbamide-4:4'-distibinic acid).

COST OF TREATMENT WITH VARIOUS ORGANIC ANTIMONIALS

Today urea stibamine is supplied to the Government at the rate of Re. 1/- per gramme. Calculating that the amount of urea stibamine required for a

complete cure is 1.5 grammes, which is frequently much less, the total cost of the drug required is Rs. 1/8/- or less. The cost of dietary of a patient during his stay in hospital for three weeks at the most, is Rs. 10/8/-. Total cost is thus Rs. 12/-. Calculating that the amount of sodium antimonyl tartrate required for a complete cure is 5 grammes and not infrequently more, the total cost is Rs. -/2/6 or more. The cost of dietary of a patient during his stay in hospital for 3 months at least, is Rs. 45/-. Total cost is Rs. 45/2/6, which is little less than four times the cost required in the case of urea stibamine. These figures show that the cost of treatment of kala-azar even in a poor country like India with urea stibamine compares very favourably with that of malaria with quinine. In private cases, the cost will be of course greater in the case of tartar emetic if one takes the doctor's fees into consideration. It is only in charitable dispensaries that the cost is likely to be less in case of tartar emetic, but the time to be spent in the case of tartar emetic is much greater than in the case of urea stibamine, and in the case of a poor man who has to earn his own food, the time element is of most importance, and the sooner he can get cured the better it is for himself and his family, if he is the earning member. The short course for treatment which is most desirable in the interests of the sick as well as of the man-power of the labourers in the affected areas who constitute the largest number of victims specially in the tea-growing province of Assam together with the great cheapness of the cost of treatment by means of urea stibamine in the present day has led to the almost exclusive adoption of urea stibamine for the treatment of kala-azar.

USE OF DIFFERENT PENTAVALENT ANTIMONIALS

It was at Brahmachari's suggestion to the director of School of Tropical Medicine, Calcutta, that Von Hayden's organic antimonials were introduced at the Calcutta School of Tropical Medicine and Von Hayden's stibosan was the first such compound tested by Napier in 1923 and this was followed by other patented antimonials, *viz.*, neostibosan and solustibosan of Bayer & Co., at the same institute. The claim has been put forward in certain quarters that neostibosan was superior to urea stibamine. But *mass observations* by the Assam Government do not confirm this belief as will be seen from the following extracts (*italics ours*) from the Annual Public Health Reports of the province of Assam. It may be added that though urea stibamine was discovered in 1920, its use on an experimental scale by the Assam Government started only from 1923. The results were so encouraging that it began to be

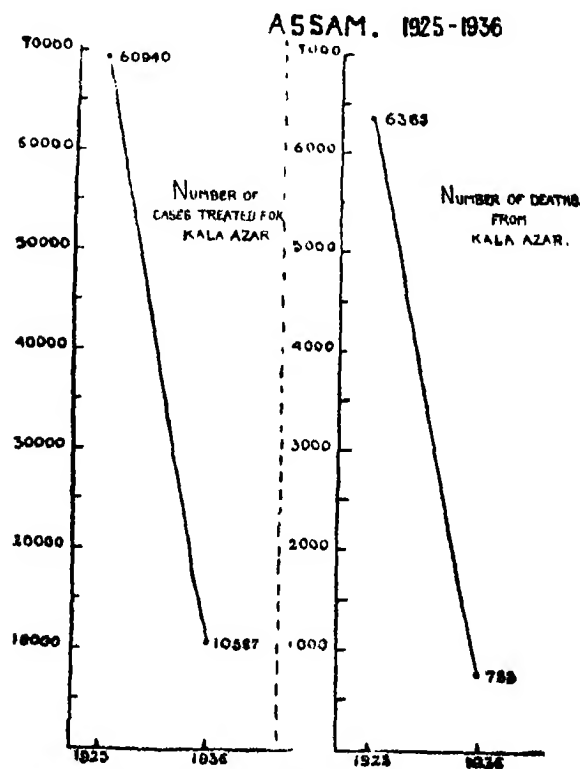
used on a mass-scale from 1928. The report for 1928 noted that most satisfactory results were obtained due to intensive treatment by urea stibamine throughout the province. From 1931, neostibosan was given a trial side by side with urea stibamine.

1932.

"Experiments with neostibosan were continued side by side with urea stibamine. *The consensus of the medical opinion received after submission of their report under review appears to be in favour of urea stibamine in regard to treatment of persons in rural areas where there is no indoor accommodation for patients at the treatment centres and where it is inconvenient for the patients to visit the centres daily.*"

1933.

"Urea stibamine was our mainstay in the treatment of kala-azar. *The treatment of kala-azar with neostibosan, which was extended to indoor patients and to such outdoor patients as voluntarily accepted it, was stopped during the later part of the year.* Neostibosan was given a trial in the



COMPARATIVE STATEMENT OF THE NUMBER OF CASES OF KALA-AZAR TREATED AND DEATHS IN THE PROVINCE OF ASSAM FROM 1925 TO 1936.

intensive treatment of kala-azar. In rural areas the results were not encouraging. Its administration was therefore restricted to urban areas only where hospital conditions exist."

1934.

"The administration of neostibosan is restricted to urban areas only where hospital conditions exist."

1935.

"The treatment of kala-azar with neostibosan was stopped in this province during the year under review."

1936.

"The treatment throughout the province is by means of intravenous injection with urea stibamine."

The comparative merits of urea stibamine and neostibosan tested in China (Lee and Chung, 1935), Greece (Lorando, 1937; Kaminopetros, 1938), France (Oelsnitz, 1934) have shown the former to be far superior.

Even if it be admitted that neostibosan and other organic pentavalent antimonials are quite as good as urea stibamine, the credit of being the first to have thought of the potentialities of organic pentavalent antimonials against kala-azar and carrying our series of extensive researches on the synthesis of organic antimony compounds will always belong to the discoverer of urea stibamine.

NUMBER OF LIVES SAVED WITH THE AID OF UREA STIBAMINE

In his annual report for 1933, the director of public health, Assam, states:

"Urea Stibamine was our mainstay in the treatment of Kala-azar. . . . Since 1923, when reliable figures for the diseases first became available to the end of the year under report, no less than 328,591 persons have been brought under treatment. It is no exaggeration to say that approximately 3.25 lacs of valuable lives have been saved to the Province."

Of course, no figures are available for the number of patients tried and cured by private practitioners in Assam, in Bengal, and other parts of India. It is well known that in India the majority prefer to be treated at home. The number of patients who owe their lives to the discovery of urea stibamine can be confidently asserted to be a figure easily running to six digits.

Further, the timely discovery of the drug prevented the spread of the disease over other parts of Assam and Bengal, and thus saved these parts

from the horrors witnessed earlier in Assam (1890-1925). The drug would have probably been just as effective in the cure of the Burdwan Fever which raged over western and central Bengal between 1854 and 1874, had it been available at that time.

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Public Health and its Planning in India*

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PUBLIC HEALTH—A FIELD OF SOCIAL ACTIVITY

KNOWLEDGE gained from successive scientific discoveries, particularly since the industrial revolution in the West, opened up new vistas of possibilities for their application to the welfare of human society, and persistent State action, sided by concurrent economic, social and political progress, proceeded side by side to develop the environmental and medical services. The evolution of public health, as is understood in modern times, may be divided into three distinct phases: (i) the period of empirical environmental sanitation, between 1840-1890, (ii) the period of scientific control of communicable diseases by the application of the microbial causation of diseases, between 1890-1910, and (iii) the period of sociological medicine, during the last 30 years.

The successive scientific advances enabled a fuller apprehension of positive health, heralded by the emergence of sociological medicine and profoundly affected the action and purpose of Statecraft. Political and economic advance was followed by legislation and State action which effected improvement of working conditions and occupational hygiene, and school health including the provision of school meals and preventive treatment of defects; prevented maternal and infant mortality; provided for health, unemployment and invalidity insurance, and for immunization against disease. Further it made provision of better and safer food, and the prevention and care of mental deficiency, tuberculosis, venereal diseases and cancer. Subsidized housing and town-planning schemes made it possible for the eradication of slums, the construction of sanitary dwellings, the provision of cheap-rental houses and the abatement of overcrowding, resulting in a great improvement in sanitation and cleanliness. The result of all these studies has led to the development

of medicine fundamentally as a social science, wherein is applied practically every basic science directed towards a comprehensive programme of community service, including the maintenance of health and prevention of disease. Hence Dr Winslow of the Yale School of Medicine (1920) defines public health as 'the science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organised community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organisation of nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health.' The cure of disease in such a programme becomes less voluminous in proportion to the rate of progress in the utilisation of scientific tools for human welfare, for the success of which science must be completely integrated*. The problems should not be faced separately but as an interconnected whole.

PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION

If we compare types of health planning in various Western and Eastern countries, India stands, at the present moment, from the public health point of view, where Great Britain stood 100 years ago, U. S. A. stood 75 years ago and where Russia stood before the Revolution (more than 20 years ago). Of the essential principles of sound public health administration, the following are some:

(1) The different health functions for the whole community should be undertaken by a single govern-

* Adapted from the presidential address delivered by Dr A. C. Ukil before the section of medical and veterinary research at the last session of Indian Science Congress at Benares.

* In the light of these concepts, a scheme on the major functions of social life has been given and the place which is assigned to public health has been indicated in the address. It has been pointed out that the "failure to establish scientific methodology in determining tools for community welfare is one of the chief factors for the present social lag throughout the world."

ing body with necessary co-operation between inter-related departments, aiming at 'centralized direction and decentralized activity'. There must be provision for efficient technical supervision and periodic appraisal of the organization.

(2) Successful administrative procedure should be based on scientific investigation and demonstration of organizational methodology in the measures whereby knowledge can be applied in practice to groups of population. Arrangements should exist for the proper training of the necessary personnel in applying such methodology.

(3) Successful administrative procedure must be based upon sound financial considerations and practicable economic budgeting suited to the area and the population.

(4) Successful community utilization of knowledge for public health reform and medical protection requires a certain level of politico-economic progress and education, for the health of the people is achieved through the people being themselves possessed of adequate education in, and practice of, health knowledge.

(5) Owing to the mutual interdependence of the inter-related spheres of social services, the requisite co-operation between them should be fully secured.

(6) In order to ensure better working and to avoid mistakes in local effort, the *whole design* of a public health planning must be before the mind from the very beginning. Any scheme, however small and localized, can confer benefit, if it is designed in relation to the scheme as a whole. Any public health planning which is not based on sound scientific and proven principles is bound to fail.

PUBLIC HEALTH IN INDIA

After tracing the trend of public health progress in British India it will be seen that, while persistent endeavours were made in countries like England to apply the knowledge gained from scientific discoveries in developing the environmental and medical services, there was no evidence here of any repercussions of the progress of scientific knowledge on the economic progress, the dawning and growth of social consciousness or the experiments in environmental sanitation. So the backwardness of India in the proper evolution of public health must be accounted for either by the progress of science not being applied to the prevention of disease as it has been done in advanced countries or to a wrong application of the same. Following factors are mainly responsible for the lag between

science and its applications in the improvement of public health in India.

Absence of any national health policy: The policy of the Government of India with regard to sanitation and sanitary staff was marked by vacillation and there was hardly any public health policy until the reforms of 1919 and 1935. These reforms have no doubt stimulated a desire for progress but it is being hampered by the lack of a planned programme and policy, a hopelessly inadequate amount being earmarked for medical relief and social services (3.4% only against 22.7% in England), by the continuance of a top-heavy administration without efficiently trained technical personnel and by the poverty of ideas in the administrators themselves. For example, a man who began as a teacher of anatomy is considered competent to be successively appointed a divisional surgeon, a port health officer, a radiologist, a teacher of medicine and so on. Furthermore, there is still considerable lack of co-ordination among the various interdependent branches of administration which are concerned with a forward health policy and social progress of the population. Administrative procedures are often applied which are not based upon sound economic considerations and financial budgeting within the economic means of the population. The result has been that although some fragmentary public health measures have been undertaken in urban areas, the rural population has been hopelessly neglected, with the result that the villager in India today is no more benefited by modern science than his forefathers before the advent of the British rule.

Violation of essential principles of sound public health administration: It has been said that social conditions react on health and health reacts on social conditions and Bernal has said that 'it is probable that an overwhelming majority of diseases that occur throughout the world are due directly or indirectly to the lack of primary necessities, generally food, and many of the remainder are attributable to bad working conditions'. In the maintenance of health, the State must provide for a social machinery to assure living standards adequate for the purpose. This refers to the improvement of economic status, nutrition, housing, physical fitness and recreation, co-ordinated with education and social assistance. Hardly any system of social assistance has been developed in India. Social assistance includes old age and invalidity pensions, compensation for physical injury or disease in the course of work, sickness benefit, unemployment benefit, etc. It must be remembered that in Great Britain, the National Health Insurance Scheme, which provides for medical assistance and other benefits in cash or kind to over 15,000,000

people between the ages of 16 and 70 years, is the largest health service outside the activities of the local bodies, which assume much more inclusive public health and social protection than in India. Prevention of disease includes impersonal services like food and drugs control, water-supplies, sewage disposal, etc., and the control of communicable diseases. The necessity for medical relief comes in where the efforts of the State to maintain the health and to prevent diseases have failed. As such, curative medicine should occupy a comparatively small place in the national health programme. This includes personal services, such as maternity and child welfare, school health and occupational hygiene and the institutions for the early diagnosis and preventive treatment of diseases—hospitals, convalescent homes, sanatoria and work colonies, dispensaries and peripheral health centres. Unless the India administration views at public health from this angle, the lag cannot be made up.

Backwardness of, and lack of methodology in, education: The lack of an aim and methodology in general education has resulted in wastage of effort and achievement of results in obtaining the necessary scientific outlook and in the intelligent participation and practice in social fields. Science is taught in a perfunctory manner in schools and the pupils seldom practise health and participate in public health activities.

Defects in the training and supply of technical personnel: The next in order of importance in health planning after developing the methodology is to train the appropriate categories of personnel in order to put into effect the methods for the whole population. The quality of medical care depends upon an intelligent interpretation of the correlation of scientific knowledge in its application to the needs of the individual. This can be accomplished only by trained and experienced personnel who realize the significance of that knowledge and give the discriminating judgment necessary for its proper use.

If preventive medicine has to have a pervading influence in all parts of the curriculum, how is this to be imparted in the successive stages? From the very beginning the teaching of the clinical and non-clinical subjects may be brought closer together in their applied and public health aspects. It is not possible to introduce this unless the teachers themselves appreciate its importance and willingly co-operate in making it a success.

We need three types of doctors—(1) practitioners for therapeutics (medicine and surgery) and general prophylactic workers, (2) public health physicians, and (3) specialists for the protection of mother and child. These may be considered as officers in the

army engaged in fighting disease but like every army the medical corps requires a large number of non-commissioned officers, such as nurses and technicians, without whom medicine will not fulfil its task. Health assistants, sanitary inspectors, midwives, laboratory technicians, dentists, pharmacists' assistants, etc., may be included in the latter category. We need also an accessory type of personnel which consists of orderlies, hospital employees, ambulance drivers, etc. Lastly, the role of voluntary workers—men and women, boys and girls, affiliated to some social service organization should not be underestimated. The education and training of each of these categories of personnel have to be attended to in its theoretical and practical aspects.

There are 600,000 villages in India and, if we have to supply a qualified doctor, with public health qualifications, to a group of say 3 villages, we shall require 200,000 trained physicians to man the peripheral units of the rural medical relief cum public health organization. Besides these, we need better trained workers for the purpose of supervision or for supplying service which requires specialized knowledge and skill. Assuming that 10 per cent. of the total personnel would be engaged in supervision work, we need 20,000 supervisors. Besides these, specialized service may require another 10,000 highly skilled doctors. This means that if we are to reconstruct public health on a new basis, we should require at least 230,000 trained doctors of different categories. As a result of scientific medical training in India for the last 100 years the number of qualified practitioners is today only 42,000. If we have to go on at this rate it will take for us another 150 years to get the required number. Russia was faced after the revolution with the same problem. She was therefore compelled to quickly increase the number of medical students to get the required number of physicians. Between 1913 and 1933 the increase was 4 times. In 1913 the number of qualified doctors was 19,785, in 1924 it was 33,000 and it now exceeds 110,000. The training of other categories of personnel, which will run into several thousands, will also have to be thought of in terms of the developing needs of the situation, in a given area.

Medical education will have to be therefore thoroughly reorganized and adapted to the new requirements. Social science must be given an adequate importance in the curriculum. It will not suffice for the student to get his training in the hospital wards alone but should be extended to community fields, in order to give him an idea of the applicability of medical knowledge towards the maintenance of health and prevention of disease in the community. The university should not only arrange to train the necessary personnel but also help in

evolving practical methods of solving the various problems and to extend those methods to the community. The appointment of a chair of medical sociology and one of history of medicine seems to be an urgent initial step.

Research and public health progress: It is needless to emphasize the importance of field enquiries in a country which is chiefly agricultural and where every variety of soil, climate, race, diet and habits is prevalent. The universities and their affiliated medical institutions have neglected to encourage applied medical research and have failed to keep a living contact with needs of the country. A thorough reorganization of the educational system, particularly in its scientific aspects, is urgently called for. Researches should be centralized in order to ensure co-ordination and avoid overlapping. The provinces may take up local problems, while the centre may take up problems of an all-India character for investigation. This necessitates careful planning and co-ordination of various schemes of research in all branches of science, whether pure or applied. Pure scientific research is as essential as that specifically devoted to the attainment of any medical, public health or industrial object. The detailed planning of research must be in the hands of those with the necessary specialized knowledge and they must be able to act without suspicion of political or racial influence. The formation of a National Research Council for India is over due. With a view to harnessing science in the service of man, it is necessary to explore ways and means for extending the existing machinery of scientific education in the country, from the school to the university stage, develop applied scientific training and research, and, finally, to see that such research is undertaken with a definite end in view and not outside the ambit of planning for public health. The most useful investigation at the present moment should be directed to the extension of medical knowledge for actual utilization by the villager. The universities in India have hitherto failed to fulfil their research function, because of the service organization and of the multifarious obligations of the workers in affiliated medical institutions.

It is necessary for this purpose to organize fundamental 'pure' research at central or university laboratories and 'applied' research in the industry itself, thus enabling a channel of communication between fundamental science and its application. Industrial medical research is successful in proportion to its co-ordination with the nationally planned organization of science.

Apart from research, the economic implications of health protection of the worker needs the develop-

ment of a well-planned system of social insurance. The system of social insurance differs, as regards its thoroughness of protection and organization in different countries; it is more thorough in Soviet Russia than in the Western European countries. Before India wishes to adopt any one system, it is necessary to study the methodology of its applications in the field. This will save unnecessary complications and wastage of efforts in future.

Supply of drugs and instruments: In spite of the fact that India abounds in all kinds of medicinal plants (Sir Ram Nath Chopra estimates the number to be 2,000) and in spite of the fact that many potent drugs had been used in India since the pre-Christian era, it is a matter of great regret and shame that no attention was paid to a rational and scientific investigation of the drug resources of India until lately by the Calcutta School of Tropical Medicine and still later by a few other centres. Although it is true that a few useful drugs have already been found, out of nearly 200 medicinal plants investigated by Chopra and his collaborators, it must not be forgotten that it has taken 20 years for them to tackle 1/10th of the drug resources of the plant kingdom.

It is estimated that approximately 90 per cent. of the population of India have to take recourse to the use of indigenous drugs, partly because drugs manufactured by the Western system are more costly and partly because no arrangement exists for the medicinal treatment of the rural population.

It would be interesting to know that during the year 1928-29, drugs exported from India amounted to Rs. 42 lakhs, while the figure for imports was Rs. 200 lakhs. Tea dusts of over 400 million pounds are annually exported at a nominal price, while it comes back to us as alkaloid caffeine valued at Rs. 6,57,600. It is understood that caffeine could be easily manufactured in India at competitive prices provided the railway freight of tea dusts is reduced. It is reported that the lag here had been the unwillingness of the Tea Associations of India in permitting the manufacture of caffeine from waste tea in India.

It is firmly believed by many pharmacologists, botanists and chemists that India can be made self-supporting as regards her drug requirements and that the treatment of many diseases could thus be proved within the means of the Indian masses, whose paying capacity is unfortunately very poor, provided there is a national planning in this regard and provided the necessary co-operation and co-ordination are forthcoming between various Government institutions, universities and non-official workers engaged in similar or allied investigations.

Financial handicaps to progress: Modern public health, which is an integral part of the social services like education, agriculture, animal husbandry, co-operation and industries, has to be paid for. It has already been pointed out that the social services in India are starved at the expense of a top-heavy administration and a high expenditure on defence and police. The salaries in the superior services in India are often 3 to 4 times higher than those paid in France or Japan. The actual amount spent on defence and police in India is higher than what appears superficially to the casual observer. The percentage of revenue on education in Britain is over twice, while that on preventive and curative medicine is nearly 7 times of what is spent in India.

It will be futile to plan a co-ordinated scheme of public health, as has been visualized here, with such an insignificant allocation to the social services. More money therefore has to be made available for them. There are three ways of finding out more money for the cash purchase of public health: (i) to make more allocations out of the existing budgets to the social welfare services, (ii) to increase the income per capita and thereby the taxable capacity of the people, and (iii) to make use of both these methods.

Lack of institutional planning: Hitherto, hospitals have developed in most countries in a haphazard fashion according to the dictates of charity or exigencies of situation regarding the occurrence of diseases. Modern medicine has made diagnosis and therapy of diseases not only a highly specialized procedure in many cases but a costly method beyond the reach of many individuals in the community.

To reach medical aid speedily to those who need it and to transport them to larger institutions where the necessary equipment and skill are available, a suitable planning in the development of communications is absolutely essential. It needs to be pointed out that communications have not been developed in India to serve the needs of sick population.

As first steps to remove the lag, every province should have a committee on hospital standardization and planning, on which the medical associations should be represented. It will be the business of such a committee to survey the needs and suggest suitable standardized plans for different categories of institutions. If this is done, it will be found to be not only less costly but the community needs will be more efficiently met through proper zoning.

Lack of co-ordination between the inter-related administrative departments: The department of public health or social affairs is intimately related

to the department of rural reconstruction, which again is related to the departments of education, agriculture and animal husbandry, industries, communications and irrigation. Owing to a lack of proper co-ordination between them, many excellent public health schemes never fructify, to the great detriment of the well-being of the population for whom they exist.

PLANNING OF PUBLIC HEALTH

It is desirable that in the provinces, the necessary co-operation between health (including housing, nutrition, physical fitness, maternal and child welfare, school medical services, hospitals and supervision of the medical profession), public relief and social welfare institutions should be co-ordinated or united in a single ministry of public health or social affairs, which keeps in close touch with the institutes of hygiene and co-operates, as much as required, with the medical faculties.

In other words, the federal and provincial governments should sit together to frame a scheme* of national planning in public health and social welfare according to modern conception and within the economic competency of the people. In order to attend to the socio-economic factor, the public health activities must be linked with those of rural reconstruction, they being mutually interdependent for success in either sphere. The improvement of sanitation of villages is possible only when the sanitation of every house is improved. Preventive and curative medicine should also necessarily go hand in hand. The preventive measures may be divided into the following categories: (i) development of a social machinery to assure living standards adequate for the maintenance of health, (ii) health education, (iii) sanitation of environment, (iv) epidemiological control of communicable diseases, (v) organization of early diagnosis and preventive treatment of disease. As curative medicine occupies a small portion of preventive medicine, it has been proposed to abolish the posts of inspector-generals and surgeon-generals and to put an officer properly trained in modern public health administration in charge of all the sections.

* In the address the essentials for the planning of public health in the federal sphere and in provinces, with special reference to Bengal, have been discussed and the working principles defined. A separate ministry of social affairs, which includes both preventive and curative medicine with the associated social services, has been proposed and that the present dichotomy of preventive and curative medicine has been proposed to be abolished, bringing about centralized control under an officer, who may be called the director of public health or social affairs.

PUBLIC HEALTH ADMINISTRATION IN PROVINCES

The posts of district civil surgeons may be abolished in view of the fact that the district medical officer of health is to function as the head of the district preventive and curative services. The district organization, as applicable to Bengal will be as follows :

- (1) *Primary Centre or Peripheral Village Unit* will include two Union Boards. This Centre will be equipped for services of both curative and preventive medicine. It will have a clinic, a dispensary and 5 beds, 3 of which will be meant for emergency aid and two for abnormal midwifery. The primary centre will ordinarily deal with the correction of minor defects and ailments, the beginnings of a domiciliary service, school health, and instruction centre for indigenous *dais*.
- (2) Four or five primary centres will constitute a *Secondary or Thana Centre*. The Thana Centre will have a 50-bed hospital, containing 10 beds each for medical, surgical, maternity, pediatrics and infectious cases. The hospital will attend to cases, act as a sorting and diagnostic centre.
- (3) Thana units will be connected to the more highly organized *Sub-divisional Centres*. Each sub-divisional centre is to have a 100-bed hospital, with 20 beds for each of the sections provided for at the Thana Centre. In addition to diagnosis and treatment of patients, these centres will act as public health service centre, experimental training centre, epidemic control centre and school health visit centre. It will be equipped with a diagnostic laboratory.
- (4) The sub-divisional centres will be connected with the more highly developed *District Centre*. The district centre will exercise all the functions of the subsidiary centres but in a more specialized way. They will also supervise the work of the whole district. The district headquarters will have a 250-bed hospital, with 50 beds for each of the different categories of services. Special beds for tuberculosis may be added to this. This hospital will be fitted with all necessary modern equipment and will be staffed by competent officers. Ten to twelve

resident doctors will be needed to run the institution under a whole-time superintendent. The voluntary services of specialist practitioners in the district headquarters should be utilized as far as possible. The laboratory attached to this hospital will undertake diagnostic, water analysis and food control work. There will be one urban and one rural demonstration *cum* training centre attached to this hospital. This will offer training facilities for sanitary inspectors, institutional and public health nurses and post-graduate and refresher courses for the higher personnel employed in the district. The whole administration will be under a medical officer of health, who will be assisted by specialist officers for the special functions of the district organization.

It will be seen that the administrative unit suggested corresponds to the political unit, which fairly corresponds to the distribution and agglomeration of population, marketing and transport arrangements. The suggested scheme is capable of expansion without essentially changing its structure. The first 5 years in this planning may be occupied in organizing curative and preventive services to units of 20,000 people. When more experience is gathered and mistakes are avoided, the unit may be duplicated or even triplicated.

The district health administration constitutes a link between the provincial and the local administrations. It should extend to social preventive medicine (health visitors, maternity and child welfare, anti-tuberculosis work, etc.), public health (housing, water supply, sewerage, etc.) and hospitals, carrying out a uniform programme everywhere and aiming at developing the various institutions into a balanced whole. The present isolationist policy of hospitals and dispensaries should be abandoned. In a planned policy, one hospital may deal with, say, acute diseases, another with chronic diseases, a third with convalescent cases and so on.

The financial side of such an elaborate scheme need not be alarming. The recurring annual expenditure of a peripheral or primary centre will be Rs. 3,000 p.a., that for a thana unit Rs. 10,000 p.a., that for a sub-divisional unit Rs. 50,000 p.a., and that for a district centre Rs. 1,00,000 p.a. This gives us an expenditure of about Rs. 2 crores for the rural public health organization in all the districts. To this should be added the cost of central or basal supervision and training centres—Rs. 1,00,000 p.a.

In addition, Rs. 20 lakhs per annum will be needed for 4 medical colleges in the four divisions of the province for training the medical and public health personnel. Besides these, a certain amount of capital expenditure (about Rs. 5 lakhs) will be needed for equipping the institutions with instruments, appliances and drugs. The development of the social assistance machinery is an urgent necessity in the furtherance of public health. The expenditure on this head cannot be visualized at this moment.

FINANCIAL ADJUSTMENT

Let us see how the expenses can be met. The urban population in Bengal is only 1/16th of the rural population. Yet the per capita expenditure on curative and preventive services in municipal areas is Rs. 2-1-9, in comparison with only 4 annas and 4 pies in rural areas. In order to divert more money to rural areas, the Government contribution to municipal areas will have to starved for some years. Excluding municipal areas, the Government contributes at present (1940-41) Rs. 87,83,000, the District Boards Rs. 35,38,000 and the Union Boards Rs. 14,21,403 or a total of Rs. 1,37,42,403 to preventive and curative services. Thus there is a deficit of a like amount in financing the suggested scheme. This can be made available from various sources. One of them is more Government allocation to social welfare services. Out of a total per capita expenditure of Rs. 2-7-5 in Bengal, police expenditure absorbs 8 as. and general administration and administration of justice together absorb 8 annas 6 pies per capita or a total of more than a rupee per head, while only 4 annas 6 pies per capita is given for education and 3 annas per capita for preventive and curative health services. Compare this with the per capita expenditure of Rs. 35-9-0 for education and Rs. 6-9-0 for medical relief and public

health in England and Wales. The other inter-related social services in provincial budgets are similarly starved at the expense of a top-heavy and mal-adjusted administrative machinery.

The scheme as suggested can be made practicable if the cost now being paid by the Government, District Boards and Union Boards is doubled. The present per capita expenditure from these sources is 2 annas 9 pies, 1 anna 1 pie and 6 pies respectively or a total of 4 annas 4 pies. By doubling the figures, the respective contributions will be 5 annas 6 pies, 2 annas 2 pies and 1 anna or a total of 8 annas 8 pies. The municipal expenditure are left out of account. This is the minimum on which a start can be made. Provided the willing co-operation of the population is secured, enough contributions in kind will be available for the expansion of the scheme. Any scheme in which the overhead charges exceed 30% of the total earmarked budget is financially burdened.

The 'First Steps' in a province, will lie with the department of rural reconstruction, which should be a co-ordinating department, and in every province set up a planning committee, with sub-committees on social welfare and other technical fields of rural reconstruction. The 'terms of reference' should be to define clearly the objective, to advise on the best way of developing and demonstrating the methodology of work proposed, to determine how best to apply the same in the wider fields around, to determine the method of training the required personnel and of proper supervision, control and maintenance of their level of efficiency, and to suggest the best means to secure the co-operation and co-ordination of the inter-related departments.*

* A list of useful references has been appended with the address which will be helpful for further details on the subjects discussed.

Research Notes

The Nature of Virus

RECENT studies have enabled us to form an idea about the size of different virus particles, the nature of virus protein, and its reaction as an immunological agent. The problem arises whether virus is the smallest living entity or the most complex of non-living phenomenon; most workers assign to it an intermediate position, having affinities with both states. The march of evolution can be conceived as having proceeded along three stages: (1) the non-living, which is completely dependent upon its surroundings; (2) the living, where independence of the environment exists in varying degree, and (3) civilized humanity where some measure of control of external events and conditions is possible (see diagram below).

Possible Control of Surroundings

Civilized Beings

Possible Independence of Surroundings

Living Beings

Complete Dependence on Surroundings

Non-living Things

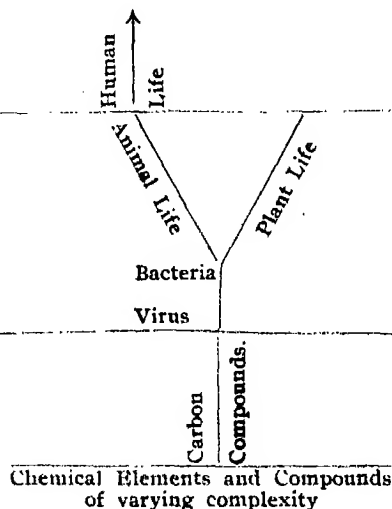


Diagram to show the relations of civilized and living beings with non-living things.

[From *Nature*, 146, p. 540, 1940 (Oct. 26, 1940).]

The virus multiplies within its host, and moves therein. It has been shown that virus can multiply within a tobacco leaf severed from the plant and

kept in a humid atmosphere. Here the various streams of transpiration and translocation within the plant are eliminated, yet the virus advances in a wave down the leaf, following inoculation at the tip. It is noteworthy that tobacco leaves scratched with a sterile needle at the tips, as for inoculation, did not permit any transfer of the inanimate dye. Similar results can be obtained with detached stems; the virus spreads upwards and downwards at about the same rate, and appears to be independent of any help from the host. In so far as the passage of a dye can be regarded as an indication of the transpiration stream, it very often follows a course different from the virus. Red ink taken up by the cut end of a shoot penetrates the vascular ring of the stem and enters the lower leaves first. The virus often proceeds first to the youngest leaves. Transport to the growing point by the stream of elaborated nutrients in this case appears to be ruled out by the fact that virus spreads downwards in the stem at about the same rate as it moves upwards. The virus, moreover, has a temperature of optimum activity different from that of its host.

With the help of these facts Dr John Grainger (*Nature*, 146, 539, 1940) ventures to suggest that the virus is actually a living organism since it exhibits a type of independent movement through its host which can only be interpreted as autonomous, and shows further independence in the calibre of its temperature relations.

It is not yet possible to formulate the actual mechanism of the movements. Sheffield has produced categorical evidence that protoplasmic connections between cells are necessary. According to many workers (Stanley, Bawden and others), the virus is a crystalline protein, different from the usual biological conception of such substances. This has been interpreted as an argument against the living nature of the virus. But virus is not always crystalline; it may occur as amorphous inclusion bodies, which look much more like the traditional protein of biology.

A. B.

'Labelled' Sodium as a Biological Indicator

THE application of isotopic indicators to the study of the metabolism of biologically important substances has opened up a new vista and unique possibility in biochemical and medical research. This method derives one great advantage from the fact that the 'labelled' or 'tagged' elements produced by the cyclotron cannot be differentiated chemically from the inactive variety. By the use of mixtures of active and inactive elements their distribution, deposition and passage through the animal body can be followed up by a measurement of their emitted radiations recorded by the electroscope or the Geiger-Müller counter.

Greenberg *et al* (*Jour. Biol. Chem.* 136, 35, 1940) has followed the metabolism of sodium in a normal or mildly sodium-deprived rats by this method. The absorption of 'labelled' sodium administered as chloride and also its rate of excretion through urine have been observed. It has been found that sodium is absorbed more rapidly in the gastro-intestinal tract than potassium and permeates all regions of the body where sodium is normally present. One exception to this was the muscle of the sodium-low rats which showed a steady increase in the specific sodium content only towards the end of the experiment. No explanation of this peculiar behaviour of the muscle tissue has been furnished by the authors.

S. R.

Synthesis of Nicotinic Acid by the Rat

It has been established in man, pig and dog, that due to deprivation or deficiency of nicotinic acid coenzyme content of liver and voluntary muscle decreases markedly which causes a few deficiency diseases. But so far no nicotinic acid deficiency disease in the rat has been reported.

Attempt has been made by W. J. Dann and H. J. Kohn (*Jour. Biol. Chem.*, 136, 435, 1940) to find whether deficiency of nicotinic acid in the diet causes a decrease in the coenzyme content of soft tissues and in addition whether the rat is dependent on nicotinic acid. Rats grown on nicotinic acid deficient diets were found to have a stunted growth, but otherwise they were active, healthy and normal. Addition of nicotinic acid in the above diet did not cause any significant difference. Estimation of tissue coenzyme in liver, kidney and thigh-muscle showed a very slight decrease (10-12%) below the normal level. The authors have also offered figures on nicotinic acid balance and have sought to prove that the rat can synthesise enough nicotinic acid to maintain a level which may be regarded physiologically normal. They have come to the conclusion contrary to von Euler's earlier work that nicotinic acid is not a dietary essential and a vitamin for the rat.

A. R.

ACCELERATING ELECTRONS

From the General Electric Research Laboratory comes the announcement of an electron accelerator, operating on an induction principle. It is a glass doughnut of less than a foot in diameter, looks somewhat like a miniature cyclotron, but is capable of handling electrons instead of positive ions. The accelerator's magnet, composed of thousands of small pieces of iron, can be used on alternating current. Instead of encircling the magnetic core by following a coil of wire as they do in a power transformer, electrons in the induction accelerator are free to circulate about the magnetic core in the doughnut-shaped vacuum tube. Hence they make many revolutions, in 200,000 of which they travel 60 miles and gain 2,300,000 volts energy. When directed against a target the electrons from the present laboratory model produce radiation equivalent to that of 10 millicuries of radium.

BOOK REVIEW

An Outline of Pharmacopoeial Drugs of Vegetable Origin—by S. N. BAL, Ph.C., B.S. (Phar.), M.C. (Mich.), Curator, Industrial Museum, Calcutta. Published by P. GHOSH & CO., Calcutta, 1940; Pp. iv+74; Price Re. 1 4as.

This monograph presents a short account of the more important medicinal plants which have been classified under (a) plants numbering 96 recognised in the *British Pharmacopoeia*, (b) plants recognised in the *British Pharmaceutical Codex* numbering 205, excluding those of B. P., (c) plants recognised by U. S. P. but not mentioned in B. P. C., and (d) plants numbering 165 used in the Ayurvedic system of medicine. The plants have been arranged alphabetically according to their botanical names, but to facilitate references indexes of common names have been appended and cross references given. The plants have also been tabulated according to the families to which they belong. There is a short account under each plant about its distribution, use and the parts used, and the plants found in India are marked with asterisks. The diagrams of six important plants are given at the end of the text. The paper and printing are quite good but the binding might have been improved. The monograph does not claim to be complete and we wish with the author that in near future he will be able to jot down his valuable experiences in a more comprehensive volume. The present monograph will, however, be welcomed by scientific workers and manufacturers of drugs, especially when the war has compelled people to concentrate on the raw materials available in India.

S. G.

Practical Applications of Recent Lac Research—Edited by DR H. K. SEN, Director, Indian Lac Research Institute, Namkum, Ranchi, India, 1940; Pp. vi+75; Price Re. 1 8as.

The present book is said to be complementary to the previous publication "*Uses of Lac*" issued from the Indian Lac Research Institute. Dr H. K. Sen, the director of the Institute, has evidently

expanded and developed the work of the Institute incomparably since he joined it in 1936. Considering that synthetic plastics are getting more and more into prominence in the world market it is obvious that researches on shellac, which is practically a monopoly of India, should be carried on with special vigour, if the market of Indian shellac is to be maintained and expanded. As Dr Sen says, however, "In view of the increased demand for shellac, it cannot be said that its use has been restricted due to competition from synthetics and there is no doubt that each is catering to its own fields of use".

The present book is eminently practical and profusely illustrated. It gives details for seed lac, garnet lac, bleached lac, hard lac resin, shellac plastics, adhesives, sealing wax, baking varnishes, oil varnishes, spirit varnishes, hot spraying of shellac and other applications. This is quite a large list and these are attempts in the right line as new uses found for shellac would be the best means for keeping and expanding the shellac market. Apart from this, however, these investigation may show that, for certain purposes other than those for which it is already in use, shellac or modified shellac is particularly useful and its value is at least on a par with that of synthetic plastics. There is also in the book a chapter on lac cultivation which gives scientific and practical direction on this question. There are seven very useful appendices concerning standard specifications, bleaching tests and manufacture of chemicals like urea, formaldehyde, melamine, granidin and calcium stearate, which have been used by Dr Sen and his co-workers in modifying the properties of shellac in various ways. There is a bibliography at the end.

As we have said above the book is of practical value but one does not fail to notice that work of fundamental scientific importance underlies most of these practical applications. For those who speak only of *ad hoc* research this is a further example to show that a simultaneous attack on questions of basic importance and on utilitarian problems is likely to yield the best results for the progress of both science and industry.

The book is written in a lucid manner and is strongly recommended to all who are interested in the subject.

B. C. G.

Report of the Indian Institute for Medical Research for the years 1938-39 and 1939-40—Published by the Governing Body of the Institute at 41, Dharamtala Street, Calcutta.

It is good to see from this Report that the Indian Institute for Medical Research which started on a very modest scale in 1935 has been maintaining steady progress since its inception. The Report is divided into sections concerning the four departments of bacteriology, protozoology, bio-chemistry and nutrition, and chemistry, immuno-chemistry and chemotherapy. There is also a report of the diagnostic section of the Institute.

This important brochure embodies the results of researches in all the above mentioned departments and gives a record of the particular lines on which work is proceeding and is contemplated in future. The department of bacteriology has carried out important work connected with typhoid toxin with *B. coli* and *enterococcus*, immunisation against *B. typhosus* by oral administration of *B. typhoid* vaccines, the effect of animal passage on the agglutinating and non-agglutinating strains of vibrio cholera, enzymes in cholera stool, and the toxicity of cholera stool, the role of *B. coli* in cholera and cholera toxin.

The department of protozoology reports progress of studies on the immunity problem of malaria. The injection of suitable malaria antigen has been shown to diminish the parasite count in monkeys and certain serological tests have been carried out which give the promise that the malaria vaccination for patients may be a reality in future or at least the requirements of quinine may be diminished in patients receiving simultaneous treatment with malaria vaccine. For this work, which is obviously of the greatest scientific and practical value, the Government of Bengal has contributed a grant of Rs. 10,000/-.

In the department of bio-chemistry and nutrition the ionisable iron in certain Indian food-stuffs and in dietaries of students, the effect of cobra venom on the ascorbic acid content of different tissues of guinea-pigs, the different factors involved in the biosynthesis of vitamin C, the ascorbigen and ascorbic acid contents of the adrenal gland, and the chemistry of the anterior pituitary like gonadotrophic hormone of the human urine of pregnancy have received attention.

Problems concerning the electrokinetic potential of *L. tropica*, adsorption of antigens by antibodies, determination of the isoelectric point of proteins by microcataphoretic methods, and comparison of the electrokinetic potentials as measured by the cataphoretic and electroosmotic methods have been investigated in the department of chemistry, immuno-chemistry and chemotherapy.

The diagnostic section has also published valuable results obtained in course of clinical examination, particularly with reference to the common bowel disorders in Bengal:

On a perusal of the Report one would like to congratulate the Institute on its work which is both of fundamental interest and of practical value as the Institute is carrying on researches under considerable financial stringency. It is good to note however that recently both the Government of Bengal and the Calcutta Corporation have given substantial grants to the Institute. As Dr J. C. Ray, director of the Institute, says in the foreward to the Report, more funds are needed for this kind of work whose scope is increasing tremendously. It is to be hoped that financial support will come to the Institute from all quarters, particularly as it has already earned recognition both in India and abroad in the brief space of a few years.

K. C. S.

Indigenous Drugs of India—by J. C. GHOSH, B.Sc. (Manchester). Published by P. K. GHOSH. Pp. xii+254; Price Rs. 3/-.

In a foreward to this book Col. Chopra pays a tribute to Mr Ghosh for his "untiring efforts in enlightening public opinion in the rather neglected field of indigenous drug industry." The tribute is well-deserved as Mr Ghosh has indeed been a pioneer in this field as is shown by the fact that the first edition of the present book was published as far back as 1919. Mr Ghosh fully deserves the credit for realising quite early both the importance of investigations of indigenous drug sources and the frightful harm that has been done by the flooding of the Indian market with spurious and adulterated drugs.

The book deals with the methods of scientific cultivation and manufacture of indigenous drugs and with the vast future possibility of the development of pharmaceutical industry in India, both because India abounds in a large number of pharmacopoeial drugs and also because investigations of Indian indigenous plants are likely to lead to the discovery of new medicaments. In this connection, it is interesting to notice that Mr Ghosh had published in

1917 certain translations from *Susruta* indicating the efficacy of chaulmoogra oil in leprosy. That was before Sir Leonard Rogers' work on the subject.

Details regarding some important drugs are given in a classified manner. The economic aspect of the question and market facilities for indigenous drugs are discussed. In general a practical tone runs through the book as is shown also by an index giving lists of Indian vegetable drugs in nine languages. There is an appendix for machineries and equipments required for pharmaceutical industries. There are also a general index and a therapeutic index.

It is however a pity that the book lacks some compactness, as many articles of the author previously published have been reprinted at intervals in this book. It would have been better if the entire theme had been dealt with as a continuous and logical narrative and all these reprints published as appendices. The appendix on "useful prescriptions" seems out of place in a book of this nature.

Those who are interested in the subject of indigenous drugs will find considerable useful information in this little book.

B.C. G.

RESEARCH INVESTMENT IN U. S. A.

Private enterprise in U. S. A. has spent as much on industrial research during the last three years as has been spent in that country on agricultural research in the past forty years. Even though the value of agricultural research has received greater recognition in recent years, and increased funds have, as a consequence, been allotted to the various agricultural institutions for that purpose, private enterprise is today spending five times as much annually on research as are the combined agricultural institutions and agencies in the United States.

The following extract from a recent American publication lends weight to the claim that money allotted to agricultural departments and other institutions for agricultural research is a sound investment rather than an expenditure. Persons interested in the expansion of agricultural research facilities by the state and federal Governments have been encouraged by the steady and healthy growth of agricultural research, especially during the last ten years which shows an increase in appropriations from \$25,760,000 to \$44,822,000. Expenditures and personnel must continue to grow if our agricultural agencies are expected to meet the demands continually made on them.

"Money spent for research is an investment. Any critical examination of the returns secured from the public's \$605,000,000 investment in agricultural research in the past forty years will show it has given and still is giving excellent returns. Our present annual expenditure of \$44,822,000 will undoubtedly yield a very high return. Surely if private industry finds a \$250,000,000 investment in industrial research essential, the federal, State and other agencies can profitably increase expenditures for agricultural research."

—With acknowledgment to the *Agricultural Gazette of New South Wales*.

LETTERS TO THE EDITOR

Effect of High Concentration Auxin on the Growth and Root Formation in *Impatiens*

In a previous communication¹ it has been shown that like the root-forming substance described by Cooper², the naturally occurring growth-substance in the coleoptile of *Triticum* is also attracted by the high concentration auxin towards the region of its application and the growth changes in the organ is directly related to the concentration of the internally contained hormone at the applied region. The question now arises whether the same substance in the plant is responsible for both the activities of root formation and growth promotion or are there specifically different substances?

Went³ suggests that the existence of some specific hormones in the plant, in the form of calines, are separately responsible for root, shoot and leaf growth. According to him caulocaline, coming from the root induces the growth of the shoot, rhizocaline from the cotyledon or leaf, induces the growth of the root, and phylocaline formed in the leaf and cotyledon is responsible for the growth of leaf. On the other hand, the investigations of other workers provide proof that the root-forming and growth-promoting substances are identical with each other. Fischnich⁴ has shown that the callus of *Populus nigra* may produce roots or shoots depending upon the concentration of auxin.

In the present investigation the effects of high concentration auxin (1% indole acetic acid) have been observed on both growth and root-forming activities simultaneously occurring in the same organ, the stem of *Impatiens*. The reactions were studied at different regions of the stem and under various morphological conditions of the plant. The carbohydrate metabolism of the treated and untreated regions of the stems was also studied in order to understand its relation with growth and root formation. The histological study of the treated region was undertaken to investigate the responsive tissue for root development and the time of its initiation.

In intact plant application of auxin at the apical region of the stem induced maximum elongation of the plant within nine days, the period of our observation; under central application the growth was comparatively less and under basal application the growth was less than that of the normal plant. The number of roots formed in the apically and centrally treated regions was almost equal; in the basally treated region the number was much less.

When the plant was decapitated its normal growth was inhibited. Treatment with auxin at the apical or the central regions under the condition, increased the growth almost equally and produced almost equal number of roots. The growth and root-forming activities in the treated plants were, however, lessened to a degree under decapitated condition.

When both the intact and decapitated plants were treated simultaneously at the apical and the central regions, roots formed in both the regions and there was increase of growth of the stem, but both the growth and root-forming activities under the condition were comparatively much lessened than in the plants of which any of the regions had been individually treated. This indicates that whether the growth and the root-forming activities had been brought about by the same substance or specifically different substances, they had been divided under double application and sufficient concentration was not produced in any one of the regions to induce the maximum activity in that region.

When the decapitated plants were completely defoliated neither growth of the stem nor root formation was possible by application of auxin in spite of the presence of root which according to the suggestion of Went is the source of caulocaline.

It has been concluded that both the growth-promoting and root-forming activities brought about by the application of high concentration auxin, are similarly effected by the morphological condition of the plant and that the source of hormone supply, whether specific or general, are the leaves and the

apical bud, since the removal of them affects both the activities alike.

In the normal plant the percentages of both reducing sugar and total carbohydrate were greatest at the apical region; in the central and basal regions the amounts were almost equal and was much less than those present in the apical region. In the treated regions the percentage of reducing sugar increased up to the third day of treatment and after that there was a gradual decline, while the percentage of total carbohydrate gradually increased in all the treated regions. In the untreated regions of the treated plant the percentages of both the reducing sugar and total carbohydrate gradually declined. In the centrally and basally treated plants the percentages of both reducing sugar and total carbohydrate when they reached their maximum within the period of our observation, did not exceed those present in the apical region of the normal plant but the ratios of the total carbohydrate and reducing sugar in those

treated regions were comparatively much higher than that of the apical region of the normal plant. It was concluded that root formation is related not merely with the increased carbohydrate content at the treated region but on the high value of the ratio of the total carbohydrate to the reducing sugar.

In the treated region the roots developed from the interfascicular cambium. The rudiments of roots were detected to form even on the third day of the treatment.

Bose Research Institute,
Calcutta, 29-1-1941.

B. Dutt.
A. Guha Thakurta.

¹ Guha Thakurta, A. and B. K. Dutt, *Trans. Bose Res. Inst.*, 13, 215, 1937-38.

² Cooper, W. C., *Plant Physiol.*, 10, 789, 1935.

Plant Physiol., 11, 779, 1936.

Bot. Gaz., 99, 599, 1938.

³ Went, F. W., *Plant Physiol.*, 13, 55, 1938.

⁴ Fischnich, O., *Ber. Deutsch. Bot. Ges.*, 56 (4), 144, 1938.
Ber. Deutsch. Bot. Ges., 57, 122, 1939.

Abnormal Spikelets of Paddy, *Oryza Sativa* Linn

In our previous note on the subject¹ innumerable variations in the number of glumes, stamens and ovaries were recorded. Irregularity in the shape of

the above parts was also found. The present observation is unlike the previous one.

In a pureline plot of Blue Rose paddy (obtained originally from U. S. A.) at Chinsurah, spikelets of single ear from a normal plant was found to bear



VARIATIONS IN THE SPIKELETS OF PADDY

membranaceous outer glumes which looked like oats. There were normal ears as well in the plant.

The total number of abnormal spikelets was 9 (nine) (Fig. 1). All of them were observed under the dissecting microscope and thoroughly examined.

The normal spikelet of a paddy consists of the following parts:

- (1) Two outer glumes.
- (2) Two inner glumes (lemma and palea).
- (3) Six stamens.
- (4) One ovary with a style and two feathery stigmas.
- (5) Two lodicules at the base of the ovary.

In the present abnormal spikelets two inner glumes (lemma and palea), six anthers, one ovary were observed as in the normal spikelets, two outer glumes only became membranaceous and fully covered the inner glumes. There were another set of two glumes down below, which were empty, i.e., whose inner glumes, stamens, ovary have been abortive (Fig. 2). This has been observed in all the spikelets. Well-developed grains were found only in the spikelet numbers 4, 5, 6, 9 and in the spikelet numbers 1, 7, 8 partially developed grains were noticed. In the spikelet numbers 2 and 3 grains did not develop at all. The grains of the abnormal spikelets were like the normal ones (Fig. 4). In all the spikelets the grains were not tightly covered by the inner glumes but remained loosely covered (Fig. 3).

From the above observations it may be concluded that only the 2 outer glumes in a spikelet were metamorphosed and developed into membranaceous structure. There were also 2 other glumes, inserted far below the axis of the spikelet, whose inner portions, i.e., 2 inner glumes, stamens and pistil were abortive.

The spikelets which developed grains in them have been kept for studying the inheritance of abnormalities observed in this case.

S. Hedayetullah
A. K. Chakravarty

Economic Botanist's Section,
Government Agricultural Farm,
Dacca, 28-1-1941.

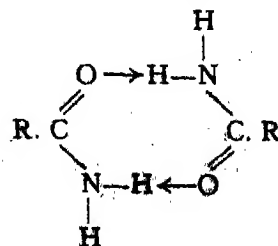
¹ Hedayetullah, S. and Chakravarty, A. K., SCIENCE AND CULTURE, 5, 177, 1937-38.

Molecular Association in Amides

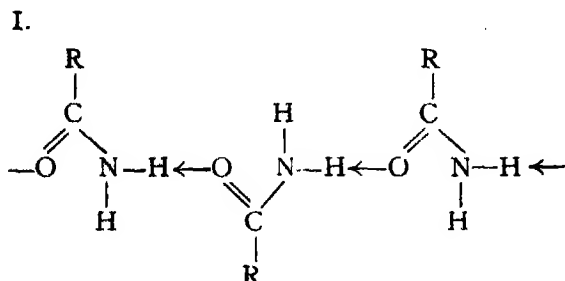
The high boiling points and dielectric constants of the amides have long been recognised as the evidence for a high degree of association. Smith¹ and Sugden² measured the parachor values of certain amides at different temperatures and found that they increased steadily with rise of temperature. A drift of this nature was explained as due to the presence of associated molecules at the lower temperature. Buswell and Rodebush³ from the study of infra-red spectra of the amides came to the conclusion that amides show a strong tendency towards association. More recently, Saxena⁴ studied the association in formamide by the use of Raman Effect.

In the course of a general investigation on the molecular association in amides and alcohols as studied by Raman Effect, the author has investigated some of the amides and the present note reports the results of work on formamide, acetamide and urea. The effect of change in temperature and dilution with water, on the molecular constitution of the amides was studied. Prominent changes have been observed in the C=O line. The changes observed in formamide and acetamide under the different conditions studied show that there is dissociation of the more complex molecules into simpler ones as is evidenced in formamide by the shift of the C=O frequency 1672 to 1680. The 1594 line almost disappears at the higher temperature and at 25 per cent. dilution. So, the lower frequency was ascribed to be characteristic of the associated molecules. Similar changes in the carbonyl frequency were also observed in acetamide.

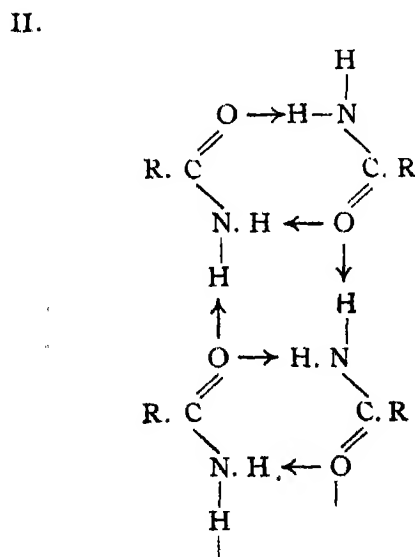
For an explanation of these results, a consideration of the molecular constitution of these substances in the pure state is necessary. It is not possible to deduce with certainty whether the intra-molecular association is the result of $N \rightarrow HN$ or $O \rightarrow HN$ bonding, and as the $O \rightarrow H$ bonding is much stronger than $N \rightarrow H$, it could be expected that the former type of binding exists in associated molecules. This is supported by the work of Rodebush and Buswell⁵ on glycylglycine ethyl ester and some of the monosubstituted amides which show definitely a strong infra-red absorption a little beyond 3μ , indicating bonded OH rather than NH. So, the associated molecule in an amide can be represented as



But in such a postulated molecule, the hydrogens not involved in bond formation of the double molecule may interfere with the formation of stable dimers. So, the association may proceed to a higher stage, as in the case of pure formic acid, and form large sized polymers as :



or by the "fusing" of dimers as :



But the formation of a polymer as represented in the second type requires the sharing of the second pair of electrons on the oxygens. So, it could be said that the amides exist in the pure state as linear polymers as shown in type I.

Full details of the results will be published in the *Journal of the Indian Chemical Society*.

A. L. Sundara Rao.

Andhra University,
Waltair, 4-2-1947.

¹ *Jour. Chem. Soc.*, 2, 3257, 1931.

² *Ibid*, 125, 1177, 1924.

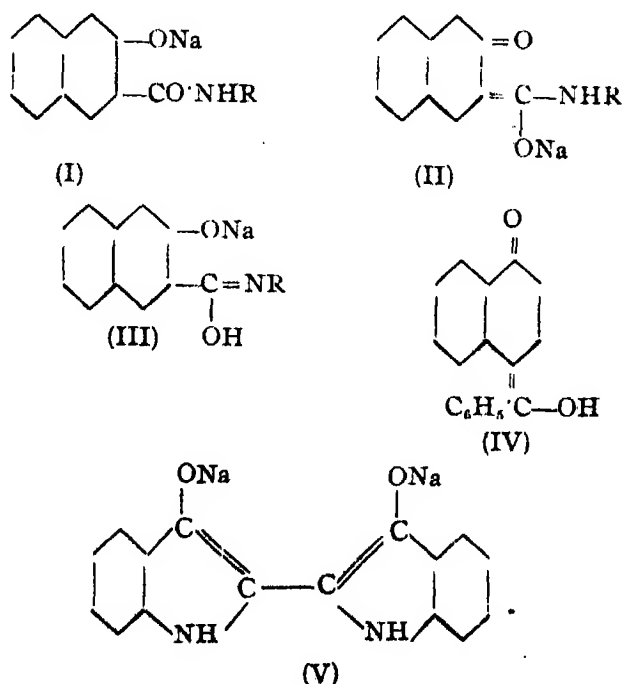
³ *Jour. Amer. Chem. Soc.*, 60, 2444, 1938.

⁴ *Proc. Ind. Acad. Sci.*, Jan., 1940, p. 53.

⁵ *Jour. Amer. Chem. Soc.*, 61, 3252, 1939.

The Quinonoid Theory of the Substantivity of Naphthol A. S. and Related Compounds

The substantivity of Naphthol A. S. and other arylides of 2-hydroxy-3-naphtholic acid has been ascribed by Krzikalla and Eisterl¹ to the residual affinity arising from the keto-enol transformation of the amide group. Bhat, Forster and Venkataraman² have drawn attention to the possible chelation between the hydrogen of the hydroxyl and the carbonyl of the amide group. Though the residual affinity and chelation hypotheses give plausible explanation of the substantivity of Naphthol A. S., they are not adequate to explain the general phenomenon of substantivity.



We have been interested in the substantivity of the hydroxy-aryl-ketones for the last two years and our observations have led us to the belief that the substantivity of Naphthol A. S. is due to the quinonoid change which it undergoes in the presence of alkali. Thus the sodium salt of Naphthol A. S. (I) has the constitution represented by (II), and the aqueous alkaline solution may be a mixture in which the various resonant forms (I), (II) and (III) are in equilibrium with one another. The quinonoid hypothesis, besides explaining the yellow colour of the alkaline solution of Naphthol A. S. is the only hypothesis to explain the substantivity of Ciba Naphthol R. P. (4-Benzoyl-1-naphthol) (IV), of the Society of Chemical Industry, Basle,³ and of other hydroxy-aryl-ketones prepared by us (unpublished work). It can also explain the substantivity of curcumin, primuline, and other substantive dyestuffs of the azoic, triphenyl-

methane and other series. We are of opinion that though all the substantive dyestuffs can be represented by the quinonoid constitution, the converse may or may not be true. Finally we wish to emphasise the pictorial resemblance between the sodium salt of Naphthol A.S. (II) and the disodium salt of leuco-indigo (V) which is known to be highly substantive to cotton as both contain the grouping $=C-C=O\text{Na}$. Complete details will be published elsewhere in due course of time.

R. D. Desai,
P. N. Joshi.

Chemistry Department,
V. J. Tech. Institute,
Matunga, Bombay, 28-1-1941.

- ¹ J. pr. Chem., 143, 50, 1935.
² J. S. D. C., 56, 166, 1940.
³ E. P. 211, 233.

A New Pathogen Causing Decay of Orange Fruits (*Citrus crysocarpa* Lush)

A fungus *Stysanus monilioides* (Alb. et Schw.) Corda was isolated from a decayed portion of an orange fruit from Darjeeling district. The decay started on one side of the fruit. The rotted region was slightly sunken with a definite margin, deep

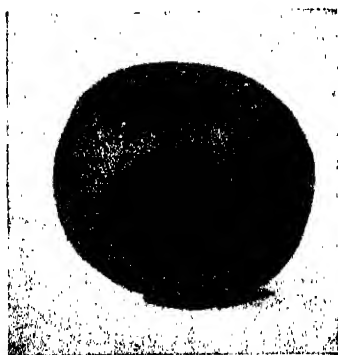


FIG. I.
An inoculated orange showing the symptoms
of decay.
(after 10 days at 24°C.)

brown on the exterior of the rind and brownish for a short distance inward on the divisions between the segments. The affected part of the rind became harder than the rest.

Inoculations were made on the rind of healthy fruits by placing a few drops of spore mycelium suspension in each of the two uniform wounds made on opposite side of the rind at the equator. The



FIG. II.
Longitudinal half of the same orange showing the
pathogen within the fruit.

wounds were made by removing from the rind, with a cork borer, a disc 5 mm. in diameter and 2 mm. deep. After inoculation the disc of the rind was fitted again and sealed by paraffin.

Inoculations without injury were also made by simply spraying spore mycelium suspension on the superficially sterilised rind. In both the cases, the fruits were covered by sterilised belljars which were lined by moist blotting papers.

It was observed that symptoms of the disease appeared only in the case of inoculation by injury.

Microscopic examination of the infected oranges showed that the hyphae of the fungus pass through the intercellular spaces in the rind and ultimately attack the pulp. The hyphae reach the central core of the segments and attack the seeds. Finally they appear through the soft portions of the stalk end. The hyphae were found abundantly in the stalks of the juicy hairs but not in the juice sacs themselves.

Among inoculated oranges stored at 12°C, 24°C and 37°C respectively, those stored at 24°C showed higher rate of decay. This is in conformity with the fact that the optimum temperature for the growth of the pathogen on Czapek's synthetic solution agar medium was found to be 25°C, with the maximum between 37°C and 40°C.

In conclusion, I wish to express my sincere gratitude to Professor S. P. Agharkar under whose directions the work was carried out.

Department of Botany,
University of Calcutta,
Calcutta, 7-2-1941.

T. C. Roy.

The Distribution on the non-null hypothesis of the Statistic, the ratio of 'between Standard Deviation' and 'within Standard Deviation'

Given k independent samples $\Sigma_1, \Sigma_2, \dots, \Sigma_k$ of sizes n_1, n_2, \dots, n_k with means $\bar{x}_1, \bar{x}_2, \dots, \bar{x}_k$ and standard deviations s_1, s_2, \dots, s_k respectively, supposed to have been drawn at random from k univariate normal populations with means m_1, m_2, \dots, m_k and standard deviations $\sigma_1, \sigma_2, \dots, \sigma_k$, we first test for the hypothesis that $\sigma_1 = \sigma_2 = \dots = \sigma_k$. If that hypothesis appears to be reasonably tenable in the light of our observations, we next proceed to test for the equality of the population means, that is, for the hypothesis that $m_1 = m_2 = \dots = m_k$. This is done by means of a statistic B/W which is distributed as

$$\text{Const.} \frac{(B/W)^{k-2} d(B/W)}{\left(1 + \frac{k-1}{N-k} \frac{B^2}{W^2}\right) \frac{N-1}{2}} \dots (1)$$

where

$$\left. \begin{aligned} B^2 &= \sum_{i=1}^k n_i (\bar{x}_i - \bar{\bar{x}})^2 / (k-1) \\ W^2 &= \sum_{i=1}^k (n_i - 1) s_i^2 / (N-k) \\ \bar{\bar{x}} &= \sum_{i=1}^k n_i \bar{x}_i / N \text{ and} \\ N &= \sum_{i=1}^k n_i \end{aligned} \right\} \dots (2)$$

For certain purposes connected with Neyman and Pearson's concept of the power of a test for alternative hypotheses and also with the concept of statistical divergence introduced from the statistical laboratory some time ago, the sampling distribution of B/W on the non-null hypothesis is needed. The non-null hypothesis in this case is that $m_1 \neq m_2 \neq \dots \neq m_k$. The author has recently obtained the sampling distribution of B/W in such a situation in the form

$$\text{Const.} \frac{(B/w)^{k-2} d(B/w)}{\left(1 + \frac{k-1}{N-k} \frac{B^2}{W^2}\right) \frac{N-1}{2}} \times {}_1F_1 \left\{ \begin{matrix} N-1, \frac{k-1}{2}, \frac{k-1}{2} \frac{\sigma_m^2}{\sigma^2} \\ \frac{k-1}{2} \end{matrix} ; \frac{(B/w)^2}{\left(1 + \frac{k-1}{N-k} \frac{B^2}{W^2}\right)} \right\} \dots (3)$$

where

$$\left. \begin{aligned} \sigma_1^2 &= \sigma_2^2 = \dots = \sigma_k^2 = \sigma^2 \text{ (Suppose)} \\ \sigma_m^2 &= \sum_{i=1}^k n_i (m_i - \bar{m})^2 / (k-1) \\ \bar{m} &= \sum_{i=1}^k n_i m_i / N \\ N &= \sum_{i=1}^k n_i \end{aligned} \right\} \dots (4)$$

It will be noticed that σ_m will be zero when and only when $m_1 = m_2 = \dots = m_k$ that is, only on what we have called the null-hypothesis. In that case (3) goes over, as it should, to (1). σ_m^2 is in some way the population analogue of B/W except for a multiplying constant. It is also interesting to note that (3) agrees in form with the sampling distribution of the Studentised D^2 -statistic announced in *Science and Culture*¹ in 1937 and published in *Sankhyā*² in 1938. I am not aware of the distribution (3) having been obtained earlier. A paper dealing with the details of derivation will come out shortly in *Sankhyā*.

S. N. Roy.

Statistical Laboratory,
Presidency College,
Calcutta, 25-1-1941.

¹ SCIENCE AND CULTURE, 3, 335, 1937-38
² Sankhyā, 4, 1938, 1938.

Voltage Stabilizers with Negative Internal Resistance

Voltage stabilizer circuits are now in common use as source of constant voltage for various physical and technological measurements. The internal resistance of the stabilizer circuits, as ordinarily used, is positive and in some cases quite high. Such circuits give quite good performance when the current drain from the source is constant. In some cases, however, it becomes necessary to maintain a constant voltage even under varying current drains. For correct performance the internal resistance of the stabilizer should in such cases be zero. Again, for special purposes, it may be necessary even to increase the voltage of the source with increase in the current drain—for instance, for compensating the increase in voltage across some other circuit element through which the current may be flowing. In such cases a voltage source with negative internal resistance, rather than a voltage stabilizer, is required.

We have recently in our laboratory introduced a simple but very effective device in the usual type of voltage stabilizer by which it is possible to reduce the internal resistance of the stabilizer to a small positive, zero, or even a negative value according to the requirement.

The device, the details of which will be published elsewhere, consists in introducing a variable resistance at a suitable place in the stabilizer circuit through which the output current is caused to flow. The voltage drop across this resistance is applied to the grid of one of the control valves of the stabilizer. The ultimate effect of this is to cause an increase in the voltage output of the "stabilizer" with increase in the current drain.

It may be mentioned that a method of obtaining negative internal resistance has recently been suggested by Hunt and Hickman¹. They use a voltage stabilizer having negative stabilization factor together with a series resistance. The method suffers from the disadvantage that in order to be effective the stabilization factor has to be small and the overall stabilization even smaller. The method devised by us, is, however, free from such defects and brings about the negative resistance feature as a property of the stabilizer circuit alone. This stabilizer circuit may be used with great advantage and economy as a bias supply system for the class B modulators used in radio transmitters. The increase in grid bias which occurs in conventional bias supply systems due to the flow of grid current when the grid swing is positive may be made zero by making the internal resistance of the stabilizer zero. The distortion due to grid circuit regulation may thereby be stopped. Further, a stabilizer with negative resistance may be used to reduce the distortion due to anode supply regulation in class B amplifiers since the grid bias is thereby made to diminish with increase in grid current. This may be accomplished with the help of the stabilizer circuit and in a manner more simple and economical than that of Rockwell and Platts² described some time ago.

My best thanks are due to Prof. S. K. Mitra for his kind interest and to Dr H. Rakshit for his constant advice during the progress of the work.

Bindumadhab Banerjee.

Wireless Laboratory,
University College of Science,
92, Upper Circular Road,
Calcutta, 7-2-1941.

¹ Hunt and Hickman, *Rev. Sci. Instr.*, 10, 9, 1939.

² Rockwell and Platts, *Proc. I. R. E.*, 24, 553, 1936.

Synthesis of Some Degradation Products of Phenolic Resinols

By the oxidation of the various alkyl ethers of iso-olivil, Vanzetti and Dreyfuss¹ isolated 3, 4, 3', 4'-tetramethoxy; 4, 3'-dimethoxy-3, 4'-diethoxy; 3, 4, 3'-trimethoxy-4'-ethoxy; 4, 3', 4'-trimethoxy-3-ethoxy benzophenone-6-carboxylic acids. The two first-named acids have also been obtained from other resinols, such as tsugaresinol, iso-larci-resinol, etc.

A method has been worked out for the unambiguous synthesis of these acids which consists in the oxidation of the appropriate 6-methyl benzophenones with potassium permanganate in pyridine solution. The acids obtained by the above method are found to have melting points identical with those

described in literature. Their identity is further established by reduction to the corresponding phthalide derivatives and decarboxylation to tetra-alkoxy benzophenones. Special importance of the method lies in the fact that the existing methods for the synthesis of benzoyl benzoic acids are inadequate for the unambiguous synthesis of 4, 3'-dimethoxy-3, 4'-diethoxy benzophenone-6-carboxylic acid. The tetra-alkoxy-6-methyl benzophenones required as starting material have been obtained by the Friedel-Craft reaction between appropriate components. Condensation of methyl creosol with veratroyl chloride gives 3, 4, 3', 4'-tetramethoxy-6-methyl benzophenone, m.p. 124-124°5. On oxidation it gives 3, 4, 3', 4'-tetramethoxy benzophenone-6-carboxylic acid, m.p. 220-221°, which is reduced to ω -(3', 4'-dimethoxyphenyl)-4, 5-dimethoxy phthalide, m.p. 187-187°5, and decarboxylated to 3, 4, 3', 4'-tetramethoxy benzophenone, m.p. 145°. 4, 3'-dimethoxy-3, 4'-diethoxy-6-methyl benzophenone, obtained from ethyl creosol and 3-methoxy-4-ethoxy benzoyl chloride, has melting point 136-136°5, whilst the melting points of 4, 3'-dimethoxy-3, 4'-diethoxy benzophenone-6-carboxylic acid, ω -(3'-methoxy-4'-ethoxyphenyl)-4-methoxy-5-ethoxy phthalide and 4, 3'-dimethoxy-3, 4'-diethoxy benzophenone are respectively found to be 214°, 169° and 128-128°5. The other compounds prepared are described below along with their melting points. 3, 4, 3'-trimethoxy-4'-ethoxy-6-methyl benzophenone, m.p. 144-5°; 3, 4, 3'-trimethoxy-4'-ethoxy benzophenone-6-carboxylic acid, m.p. 219°; ω -(3'-methoxy-4'-ethoxyphenyl)-4, 5-dimethoxy phthalide, m.p. 146-8°; 3, 4, 3'-trimethoxy-4'-ethoxy benzophenone, m.p. 107-8°; 4, 3', 4'-trimethoxy-3-ethoxy-6-methyl benzophenone, m.p. 108-8°5; 4, 3', 4'-trimethoxy-3-ethoxy benzophenone-6-carboxylic acid, m.p. 184°; ω -(3', 4'-dimethoxyphenyl)-4-methoxy-5-ethoxy phthalide, m.p. 176-7°; 4, 3', 4'-trimethoxy-3-ethoxy benzophenone, m.p. 129-9°5.

Fuller details of these investigations will be published in the Journal of the Indian Chemical Society.

My thanks are due to Prof. P. C. Mitter for his helpful suggestions and kind interest and to Mr N. Ghosh for carrying out micro-analysis of some of the compounds.

P. N. Bagchi.

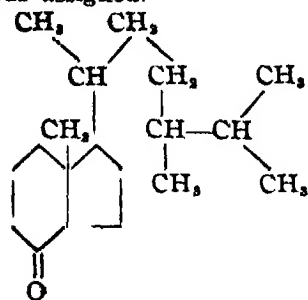
Pa't Laboratory of Chemistry,
University College of Science,
Calcutta, 7-2-1941.

¹ *Gazetta*, 64, 381, 1934.

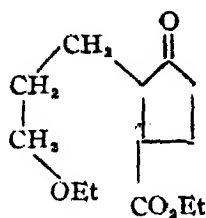
Synthetic Experiments in the Antirachitic Vitamin Series

By the ozonolysis of the dihydromaleic anhydride adduct of calciferol, Windaus and Thiele¹

isolated a ketone $C_{15}H_{24}O$ for which structure (I) was assigned.



(I)



(II)

As a preliminary to the synthesis of this ketone we have prepared the keto-ester (II). Our attempts to introduce a side-chain at the keto-group through reaction with methyl iso-heptyl magnesium iodide did not succeed. Other methods for the introduction of the side-chain are being investigated and model experiments with this end in view on simpler compounds are well in hand. After this the ethoxy group will be converted into a carboxyl and the 6-membered ring will be closed.

Cyanhydrin of γ -ethoxypropyl methyl ketone was condensed with ethyl sodio cyanacetate and then treated *in situ* with ethyl β -chloro propionate yielding ethyl-3, 4-dicyano-4-(γ -ethoxypropyl)-pentane-1, 3-dicarboxylate, b.p. $192-195^\circ/2.7$ m.m. The same dicyano ester was also obtained by condensation of ethyl α , β -dicyano- β -(γ -ethoxypropyl)-butyrate² with ethyl- β -chloro propionate. It was then hydrolysed to 1-methyl-1-(γ -ethoxypropyl)-2-carboxy adipic acid under specific conditions. The acid failed to crystallise. The corresponding tri-ester, b.p. $171-176^\circ/2.7$ m.m. was subjected to Dieckmann cyclisation, but the resulting β -ketonic ester could not be distilled in vacuum without decomposition and was hydrolysed to 2-methyl-2-(γ -ethoxypropyl)-cyclopentanone-3-carboxylic acid which was obtained as a gum. On esterification the corresponding ester, b.p. $132-4^\circ/2.7$ m.m. was obtained which gave a semicarbazone, m.p. 120° , with difficulty.

I express my grateful thanks to Prof. P. C. Mitter for his valuable advice and interest in course of these investigations and to Messrs. N. Ghosh and B. Bhattacharyya for micro-analysis.

Palit Laboratory of Chemistry,
University College of Science, P. N. Bagchi.
Calcutta, 7-2-1941.

¹ Ann, 521, 160, 1935.

² Dutta, Jour. Ind. Chem. Soc., 17, 611, 1940.

A New Source of Caffeine

THE entire amount of caffeine, necessary for our consumption, used to be imported from foreign countries before the war. As soon as these supplies

became limited, Indian manufacturers turned their attention to the production of caffeine from tea dust and tea fluff, which are available in considerable quantities. It is gratifying to note that some Indian firms, notably Bengal Chemical and Pharmaceutical Works, Ltd. of Calcutta, are now manufacturing quite large quantities of this valuable drug.

Caffeine is known to sublime at 180° without decomposition, and consequently it might be presumed that a fraction of caffeine present in tea leaves would be lost by volatilisation during the roasting process. As a matter of fact, it was noticed that a white sooty substance is actually deposited on the ceiling of the factory where the roasting operation is carried out by means of a hot blast introduced at the bottom of the roasting chamber. At my request, Mr T. P. Banerjee of the Happy Valley Tea Estate, Darjeeling, kindly collected a small quantity of the soft greyish white deposit and sent it to me for examination. I have been able to isolate from this specimen as much as 50 per cent of a white crystalline substance, which proved to be identical with caffeine.

The amount of deposit formed per day is no doubt small. On a conservative estimate according to Mr Bannerjee, about 15 g. of caffeine per 100 kg. of finished tea escape from the roasting chamber. Assuming the average caffeine-content of tea to be 3 per cent., the loss represents only 0.5 per cent of the total amount of caffeine. In a medium sized factory, therefore, the loss of caffeine by volatilisation comes up to about 7 kg. per annum. The total annual production of tea in India is 200,000,000 kg. nearly, and consequently the estimated loss of caffeine is of the order of 30,000 kg. per year valued at over Rs. 700,000/-.

There is no doubt that by suitable and effective devices, it would be possible to recover a substantial part of the caffeine lost by volatilisation. The author intends to investigate various problems connected with the recovery of caffeine from tea factories, when the manufacturing operations begin this year. It might be mentioned in this connexion that the recovered caffeine, being free from tannin and inorganic impurities, would be easier to purify, as was actually found to be the case. Moreover, the recovery is not likely to interfere with normal factory operations, and for obvious reasons, the cost of production is expected to be much lower than what it is today. It would also be interesting to investigate the possibility of recovery of caffeine from coffee factories.

The author desires to express his grateful thanks to Mr T. P. Banerjee for his co-operation and help.

Chemistry Department,
University College of Science, P. K. Bose
Calcutta, 7-2-1941.

SCIENCE AND CULTURE

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No. 10

Need for a School of Glass Technology in India

THE use of glass has become a part and parcel of modern civilisation not as an article of luxury but as one of necessity. With the beginning of the present century and more particularly after the Great War, the glass industry has had a phenomenal development based on scientific studies and is no longer an empirical art. The manufacture of glasses occupies an important position in the welfare of a nation and its use for manifold general purposes is too well-known to be stressed here. To the scientist, whether a chemist, a physicist, an astronomer, a medical man, or a botanist glass is indispensable. In modern times, glass as the basic material of optical devices has become an article of military strategy and has greatly helped in perfecting the technique of modern warfare in land, sea and air. One need only mention the naval and army telescopes and binoculars, the periscope of a submarine, the optical system of the machine guns and anti-aircraft guns, and the wonderful *bomb sight* discovered in America used in fighting aeroplanes. Apart from these, glass has recently been employed for the manufacture of such unheard-of articles as fibres, and garments have actually been prepared with glass fibres for specific purposes. It is marvellous that a fragile material like glass could be successfully used for the manufacture of furnitures like chairs, tables etc., and even for high speed machinery like centrifugal pumps. The principal cause of this tremendous development has been the increasing and organised application of scientific methods in the glass industry. While other

countries have made such an advance in the technique of glass manufacture, our progress in this field has been very meagre.

Prior to the outbreak of the Great War the condition of glass industry in some of the now leading countries, such as Great Britain and America, was very backward and probably not better than the present position of the Indian glass industry. A considerable portion of their requirements, particularly in optical and scientific glassware, were supplied principally by Germany and Austria which were at that time sufficiently far advanced in the technique of glass manufacture. Due to the unsatisfactory condition of the home industry, and to the total stoppage of all exports from Germany and Austria, Great Britain was exposed to severe handicaps. It was during this period that immediate necessity for the training of students and carrying out investigations in the various problems of glass manufacture was realised, resulting in the establishment of the Department of Glass Technology, Sheffield, under Professor W. E. S. Turner, F.R.S.,† who had no previous association with the industry and was a lecturer in physical chemistry in Sheffield University. We quote below some extracts from an article by Professor Turner on "The Depart-

† Prof. Turner was elected to the fellowship of the Royal Society in 1938, and in congratulating him for the honour, the President of the Royal Society in particular stressed his services to the glass industry.

ment of Glass Technology: its Foundation and Work since 1915":—

"There was no member of the University staff to whom such problems could specially be referred, and I endeavoured, as best I could, to provide an answer after meeting the inquirers and discussing the problems in some detail. I found it possible, *on the basis of fundamental chemical knowledge* (italics ours), to propose solutions to the particular problems, and it so happened that the solutions worked."

"Further, with the additional pressure under which all factories were operating soon after the outbreak of war, the manufacturers began more acutely to recognise their technical shortcomings and to express a desire for a better understanding of the fundamental scientific and technical basis of the industry. I was thus encouraged to proceed with my inquiries, and after visits paid to practically all the glass factories in Yorkshire, drew up a "Report on the Glass Industry of Yorkshire" for presentation to the Council of the University of Sheffield.*

"The West Riding of Yorkshire is the most important centre of the common glass-bottle trade in the United Kingdom.

The glass industry is carried on very largely by rule-of-thumb methods.

No courses of instruction in glass manufacture appear to be given in the United Kingdom.

Very little trustworthy literature exists in the English language on the subject of glass manufacture.

There is great need of research in glass-making processes.

A consensus of opinion exists among glass manufacturers in Yorkshire that courses of scientific instruction would be very beneficial to the trade.

At the present time glass manufacturers are in difficulties owing to shortage of labour and lack of good transport facilities. They are, therefore, chary of developing along new lines. On the other hand, they are unhampered by foreign competition, they recognise the unscientific state of the industry and they realise that now is the time to take counsel for the sake of preserving, and if possible extending the glass trade."

"In endeavouring to see such a Department established, I had no particular personal wish to take responsibility indefinitely for its future, as I had other plans in the course of development for the application of chemistry. On intimating my view, I was reminded that the Council had, through my initiative, set up this new Department, and that the least I could do would be to undertake its organisation. To this course, I agreed and it was my expectation, or at least hope, that it would be possible to obtain the assistance of a lecturer with special knowledge of the subject. That did not prove possible, but in Mr. J. H. Davidson, M.Sc., the first lecturer to be appointed in the Department, I had the cordial co-operation and help

of one who knew the ceramic industry and the subject of glazes thoroughly in theory and in practice. As the work of development proceeded I became, not unnaturally, involved in an increasing number of problems and of interests. The great joy of teaching students who, as adult men, clamoured for information; the development arising through contact with the Ministry of Munitions; the initiation of researches, and last, but very important, the foundation of the Society of Glass Technology and all that it involved brought me to the state, ere long, of realising how fascinating is the subject of glass; and soon all thought of relinquishing it at the end of the war passed away. I had, indeed, for better or worse, become part and parcel of the glass industry."

"It is to be noted that although representatives of the industry were encouraged to share with the University in the fullest sense the responsibility for a progressive department, it was some time before they became freely articulate. Sympathy and support, moral and financial, were never wanting, and could certainly be relied on for expression in an emergency; but, with few exceptions, it was only gradually that members began freely to open their minds in discussion at the meetings."

"Graduates from the Department and former members of the staff now occupy positions of importance in many glass-works throughout the country."

"Since that date 350 original communications and reports, covering a very wide field in glass technology, have been published. The majority of them have had direct bearing on some phase of industrial operations in the industry. There have been a number which have had to do with the more fundamental studies of the nature and constitution of glass, but as a matter of principle we have definitely avoided having our energies absorbed by problems of too academic a character."

"I have often been asked how it was that with a limited staff we could provide such an output of research work in addition to the many other activities. The only explanation is enthusiasm and business-like approach to the problem. The end of a piece of research can naturally never be foreseen, nor can the time required be estimated. But with determination and organisation much can be done to shorten the time."

"The Department of Glass Technology was the first institution of its kind to be established solely for the promotion of advanced teaching and research in glass technology. While it is an integral part of a University it has aimed at making itself also an essential part of the industry it was founded to serve."

The above lines clearly indicate that there was hardly any arrangement in Great Britain either for training the technicians or for carrying out researches in glass technology and how in the absence of such trained men, pure scientists and science graduates have successfully developed this leading institution which has been mainly responsible for the present advanced position of the glass industry in England. In all the leading glass manufacturing countries,

* The University of Sheffield took the lead because the city was the centre of glass manufacture in England.

there are adequate provisions for training of technicians and facilities for research. For example, in Germany there are technical high schools at Hanover and Karlsruhe under Professors Keppler and Zchimmer respectively who are famous for their researches in the field of glass technology. There is the Kaiser Wilhelm Institute for silicate research at Berlin-Dahlem under Professor Eitel, who is a leading authority on ceramics. There are provisions for the training of apprentices in the factories under the control of these institutions. In America and Japan there are several State colleges of ceramics teaching glass technology. Next to Germany, U. S. A. is probably the most advanced country in glass and ceramic research. A very important school of silicate research has developed at the Geophysical Laboratory, Washington under Dr Morey. In Czechoslovakia, Austria, Belgium, France there have been well-organised centres of training and glass research. But what about India? Elsewhere in this issue we have surveyed the position of the Indian glass industry. Ever since 1916, when the Indian Industrial Commission first reported on the backward condition of the Indian glass industry, it has been generally recognised that this state of affairs has been largely due to the lack of proper technical knowledge and State patronage. The Government have been singularly indifferent in their attitude. Pioneering work with great success in the matter of training was done by the Paisa Fund Glass Works, Talegaon, which has been largely responsible for the establishment of this industry in India, but due to shortage of funds, it could not develop and expand itself on modern lines.

If the glass industry in India has to be placed on a firm basis, it is of immediate importance that there should be a School of Glass Technology in a suitable centre which will arrange for adequate and effective provisions for training and research with the following objects:—

1. Training of students in glass technology (including refractories and fuels).
2. Carrying out investigations for the benefit of the industry and also fundamental research.
3. Testing and standardisation of raw materials, refractories, finished glassware etc.
4. Giving technical advice to the industry whenever necessary.

The School should be so located that the staff may be in active and frequent touch with the industry; it should therefore be established in a place having the largest number of glass factories. The success of the British attempt is largely due to the location of the School at Sheffield, which was the centre of glass industry in England. Frequent testing and standardisation of raw materials and finished goods is essential for an industry without which many of the defects in manufacture may escape detection and may lead to heavy losses.

Amongst the Indian universities, it is only the Benares Hindu University which showed initiative in this line. It first opened a Department of Glass Technology in 1936. It owed its origin to the enthusiasm of certain persons who thought that they had discovered a natural substitute for soda ash required in glass manufacture (Kishengarh State, Rajputana) which, if properly worked, would be very profitable. But the Benares school has been handicapped in its work firstly because there are no glass factories within a reasonable distance of the city and secondly because there is lack of proper organisation. With due deference to the University, we may remark that the Department was not carefully planned and the association of a foreign expert, who was appointed by the Congress Government, ostensibly with the object of helping the department, but whose duties and responsibilities to the department were never properly defined, has not been helpful. The proper course for the University would have been to appoint a committee to examine the way in which schools of glass technology have grown in other countries and then to adopt a plan suitable for this country.

In deploring the attitude of the Government towards industries we are sometimes apt to forget our own responsibilities and duties. Although in the development of glass and ceramic institutions in other countries their respective Governments have played an important role, the part played by the industrialists and the public bodies like the universities has certainly been very substantial. The Indian glass industry had so long been struggling for its existence and had thus been incapable of making any organised effort for its own development. But now it is certainly in a much better and prosperous position and we expect that it will not fail to take lessons from past struggles and failures. The feelings of suspicion and individualism should

give place to those of co-operation and organised development. It should also help in the development and organisation of a centre for glass training and research in India by generous contributions, and save itself from being exposed to dangers similar to those faced after the Great War. This is the proper time for such activities since now the industry is having a prosperous period and is comparatively free from foreign competition.

Whenever a proposal is put forward for the organisation of such a department, the question regarding the availability of expert technicians is invariably raised. The failure to organise such departments with the help of foreign experts whether under Government or private bodies has been amply demonstrated. We feel that India will have to develop such institutions with the help of her own talents. If Turner and Peddle (Dr Peddle was the first research scholar in glass technology under Prof. Turner, and has been largely responsible for the development of optical glass industry England) in England, Washburn in America, Keppler in Germany, who started their activities in glass and ceramic technology as pure scientists, could develop leading institutions in these subjects, there is every reason to believe that capable Indian scientists and graduates with industrial equipment will succeed in establishing the much needed institution. We should now shake off our inferiority complex and have confidence in the capability of Indian talents. Some people in this country, particularly those in high position are charmed with foreign experts because they think that like magicians of the Arabian Nights Entertainment they would be able to develop an industry overnight with minimum of capital and effort. But the experience of Indian glass manufacturers in this line has not been encouraging and has been well summarised

by the *Paisa Fund Jubilee* issue, 1935, in the following lines :

"The foreign experts were imported all right, but they showed little of superior skill and less of training inclinations. Barring a few exceptions, they were at the most second rate adventurers; the first class men, if any, did not get familiar with local conditions and had not their usual equipment; besides they fought shy of educated learners and above all, did not want to disclose what they considered as their secret knowledge. Finally, the glass industry, needs not one but an army of experts from the furnace builder to the packer and sales organiser; and an expert in one line was totally a failure in others. The most that early foreign experts did in India, was to initiate the people in the elements of glass making; whatever progress is made is made solely by the Indians themselves. Turning from the foreign experts for whom we have little use, we find the students trained abroad equally disappointing".

But to avoid adventurers, caution will have to be exercised in selecting such people. After they have shown their capability for such work and sincerity to justify confidence, facilities should be afforded to them for going abroad to maintain contact and work in foreign institutions with a view to improving their methods of training and research. The practice of sending abroad raw graduates for industrial training has not and could never be very fruitful and was in fact criticised by the Industrial Commission as early as 1916. In view of there being so many glass and ceramic factories round about Calcutta, the latter can be a suitable centre for such a school and we invite the attention of the Calcutta University authorities to this problem specially when there are already departments in applied sciences.

We have written these lines in the spirit of constructive criticism and for focussing public attention on this growing need. We sincerely hope that this problem will receive serious consideration before it is too late, as we feel that now is the most opportune moment for making such an effort.

The Indian Glass Industry

A GLASS TECHNOLOGIST

ALTHOUGH modern writers do not regard Indians to be the discoverers of glass, there are proofs, as for example, the mention in the Vedas* of female ornaments made from glass, which indicate that this material was in use in this country probably before its discovery whether by the Syrians or the Phoenicians. The wearing of glass bangles by Hindu women, apart from its artistic aspect, has been regarded as a religious duty of womanhood and even with the influx of western civilisation, this practice has not been discontinued. In the medieval period, glass was manufactured in India and the spangle glass still prepared in some districts of the Punjab is a relic of those days. Sir Alfred Chatterton in the Indian Munitions Board Handbook remarked as follows:

"In the sixteenth century there was an established industry which had not advanced beyond the stage of producing a very inferior material, utilised almost entirely for the manufacture of bangles and, to a very limited extent, for small bottles to hold perfumes (*atar*) and for flasks in which to store Ganges water".

EARLY HISTORY

But in the present times, India occupies a very low position in the modern glass industry. The early history of this industry in this country is a long tale of failures and constitutes an instructive study in the history of industrial development in India. The first attempt to introduce glass industry on modern lines was made by Whympers, manager of the Murree Brewery, who with the help of a German expert started a glass bottle factory at Jhelum in 1870. The factory was however soon closed down on commercial grounds. The first glass factory under Indian management was started at Titaghur (under the name of Pioneer Glass Works) in 1890 with an Austrian expert and after a hard struggle of about ten years had to be closed down due to want of technical men, the foreign employees having deserted the enterprise. Quite a large number of unsuccessful attempts were made after this period and most of

them with the aid of foreign experts. Some of these factories, however, struggled hard and exist even today, though under different names notably at Allahabad, Amballa, Bahjoi (dist. Moradabad, U.P.), Talegaon (near Poona).

A careful analysis of so many failures in these early attempts to establish glass industry in India leads one to ascribe them to the following reasons:

1. Lack of efficient organisation, i.e., quarrel between experts and financiers.
2. Foreign experts' ignorance of Indian conditions and financier's impatience for quick results.
3. Lack of technical skill on the part of Indians and consequent dependence upon foreign experts.
4. The improper location of the factory in some cases, as for example, a factory at Rajpur (on the Dehra Dun—Mussorie Road).
5. Lack of any interest or initiative on the part of the Government to help this struggling industry.

The industry did not suffer due to lack of raw materials in the country; since most of them such as sand, lime, fuels, refractories were known to exist in India. In the case of soda ash, even in the past, country-made product was used by some of the manufacturers.

In the early days of the industry, the association of foreign experts mostly glass blowers whether Germans or Austrians did not prove very helpful. The Japanese experts were to some extent successful in these attempts and one thing is however evident that the industry adopted Japanese methods of glass manufacture in preference to those practised on the continent of Europe. The reason for this adaptation was the suitability of the Japanese pot furnaces to small units, less expenditure in the initial stages and to the comparative ease of working them, requiring less machinery.

The manufacture of glass had fascinated the people so much, that even in the face of so many failures, fresh attempts had not been wanting to

* Watt's Dictionary of Economic Products of India, Vol. III, p. 504.

establish the industry in India; one of the causes of attraction being the heavy imports of glass articles worth more than rupees two crores and the availability of the raw materials in the country. Apart from the development of this industry on modern lines, the manufacture of glass bangles, a special article of Indian requirements, was also being pushed on in India chiefly at Firozabad in the United Provinces where it is said to have been started from the Mughal days. This began entirely as a cottage industry with very little co-ordination and the art of making bangles has passed down from generation to generation with the result that there is now a definite class of Muslims at Firozabad known as *Shishgars* (the glass makers). The glass bangle industry never attracted a large capital and was adopted mainly as a part-time occupation of the individuals. During the early days, bangle-makers used broken pieces of glass and melted them along with soda ash from *reh* or saltpetre in their very crude wood-fired furnaces. The products were not very attractive and could be sold only at very low prices in competition with the superior imported Czechoslovakian and Japanese bangles. One of the reasons why this branch of the glass industry did not face many failures, although not very prosperous, was the indigenous character of the technique; it was not an imitation of other people's practice. Also it did not require large furnaces, complicated machinery etc. Hence it did not involve much capital and consequently it had less risk of heavy losses.

During the period of the early struggles of this industry which was mostly initiated by individuals not having much financial resources, the Government do not appear to have been even aware of the existence of the industry at all, and nothing was done to find out causes of failure. It is estimated that the country suffered a total loss of about half a crore of rupees even in these small adventures.

THE GREAT WAR PERIOD

The outbreak of the Great War gave a momentary impetus to the Indian glass industry due to the stoppage of imports from the major exporting countries, which were on the enemy sides. Belgium, though on the side of the Allies was under enemy occupation and the position of glass industry in Great Britain was far from satisfactory and inadequate even to meet the home demands. Japan seized the oppor-

tunity and established a very substantial market in India, where it had previously almost no position before the War. The condition of the glass industry in India was nearly hopeless though there was a ready market and in spite of all efforts, it could supply only a fraction of the country's requirements.

New factories were opened to meet the demands of the country. Several glass bangle factories were started at Firozabad and it was at that time that this section of the industry became well established at this centre. Some factories started to manufacture lamp-ware, bottles, jars tumblers etc., whilst due to the demands of the Munitions Board others are stated to have produced even scientific glassware* though of an inferior type. The industry had thus an expansion in its activities.

WORK OF THE PAISA FUND GLASS WORKS

But what were the causes of success in the expansion of the industry during the war? Apart from the manufacture of bangles, this success was largely achieved due to a supply of some capable Indian technicians trained by the Paisa Fund† Glass Works at Talegaon.

This factory or we may better say institution has played a fundamental rôle in the development of the modern glass industry in India, in that it supplied the real need of the industry, *viz.* trained men. The Glass Works at Talegaon were started in 1908, from the collections of the Paisa Fund with L. Ishwar Dass Varshney, one of the pioneers of the Indian

* This passage is taken from Indian Tariff Board Report of 1932, but we are doubtful if any scientific glassware was at all produced.

† The "Industrial Fund or Paisa Fund" was first registered on the 16th October, 1905 and was started mainly through the efforts of an ordinary Maharashtra village school teacher, A. D. Kale. To enlist the wide support of the public, the minimum contribution was one pice per year and that is probably the origin of its name, Paisa Fund. Its chief aim was the industrial advancement of the country through training and being conceived with such lofty and nationalistic ideals it had the active support of patriots like the late Lokmanya Tilak. A number of public men notably from Maharashtra such as the late Dr. Deshmukh, Mr. N. C. Kelkar served as presidents of its governing body. When the funds amounted to about ten thousand rupees, a glass factory was erected at Talegaon near Poona, mainly with the object of training students in the art of glass manufacture. The funds have accumulated to some lakhs of rupees now. Apart from glass, the Fund has extended its activities in certain branches of ceramics. Facilities have been provided to deserving students for training abroad. Although founded in Maharashtra and most of its subscribers are from that province, the institution has all along been cosmopolitan in character. This is one of the rarer institutions which has amply demonstrated the achievements of organised public efforts in the absence of State aid.

glass industry, who had received his training in Japan and Mr Karandikar, M.Sc., with the specific object of training students in glass technology both in theory and practice. This institution was the first to realise that one of the principal reasons of the failures of the glass industry in India was the paucity of trained Indian workers. The realisations of this fact and its rectification by the activities of this organisation has earned for it a unique and honoured position in the development of this industry. The technical staff of most of the present glass factories in India whether managers or glass blowers have either been trained at these works or under persons who received their training here. India needs more institutions with such selfless and missionary ideals and we take this opportunity of expressing our appreciation of its invaluable services rendered to the country and for the very clear judgment and foresight exhibited by its organisers. It is indeed surprising that the pioneering efforts of such a missionary organisation did not at first receive any encouragement from the Government; on the contrary it was looked upon with suspicion, as is evident from the following extract taken from the Paisa Fund Silver Jubilee Number, 1935:

"During this period (1908-1915) the fund successfully came out of the ordeal of a surprise audit by the C.I.D. people who conceiving a certain suspicion of the Fund's activity examined its books, but to their chagrin found them in order and free from any connection with political or revolutionary activities."

The Indian Industrial Commission appointed during the Great War of 1914 appreciated its work in the following terms:—

"Useful work has been done by the Paisa Fund at the Talegaon Glass Works and it is certain that the recent developments of the glass industry in India have only been possible by reason of the blowers trained in this factory."*

THE POST-WAR PERIOD

After the conclusion of the war, imports of glassware began to pour into India at a very rapid rate and the temporary protection afforded to the industry due to abnormal conditions created by the war almost disappeared. Such a sequel was only natural and was in fact predicted by the Indian Industrial Commission, who based their argument on the finding that other neutral countries had also developed their resources, particularly manufacture of

glassware. Moreover the belligerent countries, after return to normal conditions, began to intensify their industrial activities with a view to get back the lost markets. The Indian glass industry which was still in its infancy and was following *laissez faire* methods, fell an easy prey to such conditions with the inevitable result that the market was dumped by foreign imports and several factories had to close down. As a matter of fact, the year 1920-21 witnessed the highest imports of glass articles into India as is evident from the following Table.*

Total imports (in rupees)	Year.
1,54,37,010	... 1911-12
1,75,33,965	... 1912-13
1,94,52,795	... 1913-14
96,51,635	... 1914-15
1,06,44,495	... 1915-16
1,50,09,165	... 1916-17
1,62,45,885	... 1917-18
1,24,60,665	... 1918-19
1,99,80,940	... 1919-20
3,37,61,820	... 1920-21
2,22,49,432	... 1921-22
2,59,60,467	... 1922-23
2,45,74,237	... 1923-24
2,60,01,338	... 1924-25
2,59,45,644	... 1925-26
2,52,88,239	... 1926-27
2,48,40,850	... 1927-28
2,37,49,480	... 1928-29
2,51,93,168	... 1929-30
1,64,77,940	... 1930-31
1,21,97,209	... 1931-32
1,42,46,926	... 1932-33
1,22,13,444	... 1933-34
1,30,75,000	... 1934-35

THE SECOND SWADESHI MOVEMENT

The second Swadeshi Movement of 1930 gave the much needed protection to the industry, which was at that time experiencing conditions almost similar to the pre-war period. The bangle industry at least owes a debt of gratitude to the national sentiments of the Indian women for the increasing use of indigenous products. The bangle-makers at Firozabad have improved their technique fairly well and in quality their products compared well with some of the imported stuff. The glass industry as a whole had also developed and articles much better in quality than in the pre-war days are being manu-

* Report of the Indian Industrial Commission, 1916-18, p. 369.

* Paisa Fund Jubilee, 1935, p. 94-95.

factured. There are some factories which have installed automatic and semi-automatic machines for the manufacture of sheet glass, bottles, etc. The total value of the articles manufactured has also increased. The tendency to instal better furnaces has also been growing steadily. Better refractories and even pots which are one of the principal requirements of the glass industry are being manufactured in India. In short, it may be said that the industry as a whole has made considerable progress after the war and specially after the Swadeshi Movement.

We can now say with some degree of confidence that the glass industry has come to stay, after a long series of struggles against heavy odds and this fact alone is a tribute to the enterprising spirit and stamina of the Indians. It is occasionally said that the Indians lack in skill and enterprise and this is one of the reasons of the slow development of industries in this country. The example of the glass industry establishing itself in this country, in the absence of any State aid whether financial or technical, and mostly developed by indigenous talents should be sufficient to contradict the above statement. May we say here very politely that the condition of the glass industry in Great Britain was very unsatisfactory at the beginning of the Great War and probably not better than that of the Indian glass industry now. The successive growth and development of this industry in Great Britain have been possible mainly due to the increasing application of science, as a result of organised research and training in which the Government have played a very important rôle. But the industry in this country has not been fortunate to receive the patronage of the Government. This patronage is very much needed, for even with all the developments, one should not forget that the glass industry in India is still in a very backward state compared with the advanced countries. With few exceptions, the glasses usually manufactured are of the soda-lime-silica type and the technique of preparing special and coloured glasses has yet to be developed. Most of the glassware produced so far, with the exception of some sheet glass manufactured chiefly at Bahjoi, is hand-blown. The industry has a tendency to improve its methods and expand its activities.

INDIFFERENCE OF THE GOVERNMENT

The first authoritative body to invite the attention of the Government to help the glass industry was

the Indian Industrial Commission of 1916, which definitely stated as follows:—

"War profits and increasing practical experience have greatly strengthened the position of manufacturers; but the technical knowledge at their disposal is limited, and rapid progress is only possible if adequate steps are taken to remedy this defect."

"An organisation is wanted to take up the whole industry, including men who can deal with the furnace problem, the preparation of refractory materials for furnaces, crucibles and pots, the chemistry of glass, the manipulation of the crude product and its conversion into finished forms, whether by skilled blowers or by highly complex and semi-automatic machinery."

"Protective tariffs may bolster up the existing factories, but they will prove ineffective, unless they give rise to scientific enquiry and expert treatment of the many problems involved. To establish a tariff and then to trust to private effort is not likely to be productive of satisfactory results. Clearly, the State should take the lead, employ the experts, and place them in charge of practical work; and if tariffs are employed, it should only be so far as is necessary to protect the industry in its infancy."

Sir Alfred Chatterton in his article on the "Manufacture of Glass in India" referred to earlier, in the Indian Munitions Board Handbook remarked:—

"The glass industry has come to stay, but without aid from the State, it is likely to make very slow progress in the future".

After the termination of the war, the Government did not pay any heed to these clear and straightforward recommendations and left the industry to its own fate. So a crisis was allowed to overtake the industry owing to the sudden dumping of Indian markets by imported goods, whereas in England the home country of our rulers, the same industry was being carefully nursed in various forms so that a high standard of perfection and independence could be achieved. The only assistance that incidentally came to the industry was the increase of revenue duties from 15 to 25 per cent. in 1931 during the time of general economic depression.

THE INDIAN TARIFF BOARD ON GLASS INDUSTRY

In 1931, in response to the request of several glass manufacturers for protection to the glass industry, the Government appointed a Tariff Board with Dr J. Matthai as chairman. The following are some of the extracts from the report of this Board.

"We are therefore satisfied that on the balance the glass industry does possess such natural advantages as to justify its claim for protection".

"It is generally recognised that even in its simplest forms the glass industry is highly technical and requires for its development a high degree of skill and scientific and mechanical equipment. The difficulties experienced by Indian manufacturers of glass are to be attributed largely to the lack of adequate provision for the investigation of scientific problems connected with the industry and for the training of managers possessing the requisite knowledge of technology and modern methods of manufacture. We are convinced that unless any tariff assistance granted to industry is supplemented by suitable organisation for training and research, the progress of the industry will be slow and incommensurate with the burden which our proposals will place on the country."

"But along with investigation and research, facilities should also be provided for training Indians for the posts of managers and scientific assistants in glass factories."

"In concluding our discussion of these proposals, we desire to emphasise the view expressed earlier in this chapter that no permanent development of the glass industry in India will be achieved unless provision is made immediately for research and training on the lines we have suggested, and that assistance by means of tariffs alone may prove in the long run entirely fruitless. We have observed with growing apprehension that when proposals are made by the Tariff Board to supplement protective duties with more constructive methods of assistance, no tangible efforts appear to be made to give effect to such proposals. If this practice is continued, the policy of protection may yield few results of any value as regards the development of the industries and may in the end prove little more than a convenient means of raising additional revenues. In our recent report on the Paper industry, we pointed out how the rejection of the Board's proposal to grant direct assistance to the industry resulted in unduly delaying the development of bamboo pulp. We made a similar proposal in our report regarding the sugar industry as "a condition precedent" to the grant of protection, on which also no action has apparently been taken so far. Protective duties divorced from the constructive measures proposed in connection with them may represent an immediate gain to public revenues but they constitute in reality an expensive and possibly wasteful form of assistance to industries. We are constrained to express our views strongly on this question because we feel that unless public attention is directed to it, important national interests may be jeopardised. In no case which has come under enquiry by the Tariff Board has this question been more forcibly brought to our notice than that of the glass industry. For this reason we trust that the proposals put forward in this chapter will not merely receive sympathetic consideration but will be implemented without delay."

The above lines clearly demonstrate the great emphasis laid by the Board on the immediate and complete adoption of the measures recommended by it showing incidentally that it had fully realized the mischief done by the half-hearted and piecemeal measures of the Government. The Board submitted a report to the Government in March 1932, but the latter did not issue it till 1935, for reasons best known

to themselves and refused to do so even on repeated requests from the glass manufacturers. This report which was so characteristic of the chairman was a pointed reminder to the Government and strongly recommended protection to the glass industry, requisite provisions for the training of technicians and for research on adequate scale. With regard to the latter, its findings were very thorough and far-sighted as is evident from the following extracts:

"We propose that the staff should consist of one glass technologist who will be the head of the department assisted by one senior assistant and three or more junior assistants. Provision should be made also for studentships for graduate research workers and for laboratory assistants together with the necessary office staff. Much of the apparatus required for the work is already in the Institute (the H. B. Technological Institute, Cawnpore) but some provision would be required for special equipment at the beginning and also an annual provision for materials and equipment and for the travelling expenses of the staff. We estimate that the total annual expenditure will depend largely on the personnel of the staff whose work in the initial period will determine the ultimate success or failure of the scheme. This applies particularly to the glass technologist who will be required not merely to carry out the current duties of the department but to lay down at the beginning the main lines of work and to organise the department. He should, in our opinion, be a man who combines the qualifications of a first class research worker in glass technology with adequate experience of both the practical and commercial aspects of the glass industry. He should at the same time possess sufficient personality and tact to enlist the sympathy and co-operation of glass manufacturers and to work in harmony with the management of the Technological Institute and with his colleagues. We have pitched our estimate of the qualifications required for the head of the department at a high level because we are assured that a scheme of this kind would be entirely ineffective unless it was adequately manned. It would probably be impossible at the beginning to secure the services of an Indian having the necessary qualifications. In that case we suggest that a suitable man should be recruited from abroad for a limited period on the distinct understanding that at the end of the period his place would be taken by his Indian senior assistant. We therefore consider that the senior assistant should be chosen with special care. He should be a person of high scientific attainments preferably with industrial experience and possessing the personal qualifications required for administering the department when he is placed in charge of it. The other assistants should be chosen from among young Indian graduates who have distinguished themselves in physics, chemistry or engineering and have shown an aptitude for research."

The Government did not agree with the recommendations of the Board and turned down the demand for protection. This fact alone is sufficient to demonstrate the hostile attitude taken by the Government, but somehow probably to stop agitation they made a show of giving effect to the recom-

recommendations regarding research but in their own way and the newly created machinery of the Government, viz., the *Industrial Research Bureau* was asked to undertake the survey of the glass industry by its Assistant Director (who by the way does not appear to have done anything on, or known anything about glass previously). This step was quite useless and redundant as the report of the Tariff Board published just then was quite comprehensive and accurate. When one remembers that this report was submitted by a Board mostly consisting of Government officers of proved ability, and rank, the duplication of the work by the assistant director, who was not a glass technologist indicates that the Government did not like the Tariff Board report but wanted another type of report. This officer after a long period and extensive tours, which must have cost enough, produced a report in which there was nothing original; it was a rather very poor show by the side of the exhaustive report of the Tariff Board. It was however helpful in one way that it made possible for the Government to back out of the embarrassing position of granting protection and rendering technical assistance as recommended by the Board, under the plea that the condition of the industry was bad, mainly due to inefficient furnaces. The designing of improved furnace was entrusted to this very officer who after three long years produced a design whose efficacy is yet to be demonstrated. The Government thus shelved the Tariff Board's recommendations and asked the industry to wait and hope. We may emphatically remark here that the appointment of such isolated people under Government agencies serves no purpose.

From the foregoing account it is evident that the Government had not only been indifferent but even antagonistic to the development of this industry in this country. As a result of this long struggle and such activities of the State, a feeling of suspicion and disgust has grown amongst the manufacturers and they do not seriously expect anything from Government departments.

FACTORS FOR SUCCESS OF THE INDUSTRY

Broadly speaking, in considering the successful establishment of any industry, the following items have to be carefully considered.

1. Availability of raw materials.
2. Location of the factories.

3. Market.

4. Direction, both technical and commercial.

With regard to the glass industry, nearly all the important raw materials are available in the country and with the establishment of the Alkali and Chemical Corporation and the Tata Chemicals Ltd. even soda ash, a costly and indispensable material in glass manufacture hitherto imported, will now be available in the country. Moreover, due to the ever-increasing demands of the iron and steel industry, better refractories are now available in India which though not direct raw materials, are one of the fundamental requirements of the glass industry. A proper and detailed survey of these materials is however necessary.

Location of factories is certainly a very debatable topic and can occasionally make all the difference between success and failure. The most salient points governing their location are constant availability of raw materials, nearness of markets and supply of efficient labour. Some people however lay great emphasis on locating factories near the source of raw materials. This is however not always very helpful and sometimes question of freight on finished goods and nearness of market become the deciding factor. Glass is a fragile article and thus liable to greater losses during transit if it has to be hauled over long distances. It is apparent therefore that the nearness of the market plays an important part in the location of the glass factories and this fact is evident from the success of so many factories far removed from the raw materials, such as those in northwest U. P. and the Punjab.

Regarding the scope of the market, India imports glass goods to the extent of more than one crore of rupees. Moreover, with the increase of industrialisation and the general advancement of a economic life of the country, there is every likelihood of greater utilisation of glasswares. Even if there could be no expansion, the present market is enough for its development and there need be no apprehensions with regard to this point. It is evident that so far as the availability of raw materials and scope of the markets are concerned, the industry has every thing in its favour for further development and expansion.

APPLICATION OF SCIENTIFIC METHODS

Taken as a whole the glass industry is highly technical in nature and requires for its development a sound knowledge of sciences like physics and

chemistry, and of engineering, specially of furnace designing, etc. In other countries also, notably England and America, the condition of the glass industry was not very satisfactory before the Great War and as a matter of fact the present advanced position of these countries in this industry is largely due to the increasing application of scientific methods to glass manufacture in the post-war period. In India, the present conditions of technical training in glass manufacture and arrangements for research are not at all satisfactory. It is to be feared that with the present backward state of technical knowledge which alone apart from other factors has been largely responsible for its past miseries, the industry may not be able to stand the severe competition to which it is likely to be exposed after the present war. The industry does possess natural advantages and if it could have the benefit of trained Indian personnel, there is no reason why it should not be able to establish itself more firmly than otherwise. The present war more than anything else has brought into prominence the necessity of having trained technicians in the country. Some other factories, though possessing plant and resources, could not avail of the present opportunities of the markets because their experts being of enemy nationality have been interned for the dura-

tion of the war. Fortunately glass industry did not have many foreign experts, but the paucity of Indian technicians of the requisite standard cannot be denied. The problem of technical training and development of indigenous talents to shoulder responsibility is therefore an urgent one before the industry. We have every reason to believe that given proper facilities, there will be no dearth of scientific talents in this country to develop glass technology along scientific lines. In our editorial in this issue we have examined these questions and have indicated the lines along which the organisation of a centre of training and research in glass technology can be undertaken.

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TRANSFERRING SEA POPULATION

The Soviet Ichthyological Research Institute has decided to replenish the fauna of the landlocked Caspian Sea and as a first measure they are transporting Nereis, the Polychaete worm relished by the sturgeon, bream and other fish from the Azov Sea in isothermal boxes. Experiments during the past three years have shown that this worm is able to withstand change in salinity and temperature and is unaffected by lower contents of oxygen.

—Nature

The Electric Eye

ANDRE LION

UTILIZATION of intangible forces is a characteristic of modern technical development. Electricity has sweepingly replaced steam and motor power. Radio and television span the universe. The light beam and lately, even the invisible short-wave, in combination with the miraculous photo-cell now have become a highly valuable help in machinery, traffic, even in sports and everyday life. Commonly known as the "Electric Eye", the photo-cell is a rather unobtrusive-looking little device, e.g., a copper disc with an oxide coat on one side. But it is as sensitive to light as the human eye and amazingly, its sensitivity to the visible colours of the spectrum follows closely that of our eye, although the eye is one of the finest and most complicated organs of the body, and the electric eye is just a coated metal plate.

Strange to say, it is even more powerful than our eye. Our organ needs the meditation of the brain to transform its impressions into actions and reactions. The photo-cell, on the other hand, is capable of directly transforming light energy into electric energy,—a miniature light-operated generator. You simply interrupt the light beam aimed at an electric eye and you automatically switch on the burglar alarm. The beam of your car's head-light wakes the sleeping little cell and the garage door opens immediately. You approach a show-case or a shop-window, unknowingly cutting the invisible light connection between a feeble light source and the little cell, and thus automatically you switch on the window illumination. In these cases the increase or decrease in the light amount falling upon the photo-tube has influenced a feeble electrical current; this current has been amplified and thus has been enabled, just by closing a circuit, to start or stop a motor, switch on the light, ring a bell, sound a horn.

Elevators in American modern houses level today perfectly as they stop at the various floors. Thousands of electric eyes are at this job. Two of them, one at the top and the other at the bottom

of the elevator, are covered and thus protected from light rays when the elevator is in exactly the right position; if it stops too low, the upper cell is uncovered and, energized by its light beam, operates



Formerly it has been the practice to turn beacon and airport lights on and off with an astronomical clock, the switches being set to close 15 minutes before sunset and 30 minutes after sunrise. Now the United States Department of Commerce has set up installations using Electric Eyes. They actually "see" the amount of light received, regardless of hours and minutes or any source of information other than light intensity. They are so reliable that they function if heavy clouds should cut the light below the intensity required for safety even at high noon.

a relay to pull it up to the proper position; if it stops too high, the lower cell in a like manner pulls it down. No more warning is necessary to "watch your steps" in passenger elevators. And for freight elevators where materials have to be rolled on and

off it is of still greater importance that they are exactly level with the floor.

Speaking of elevators, the Westinghouse safety ray is a modern device of protecting passengers entering or leaving an elevator from being hit by a closing door: two light beams cross the door-opening, hitting two photo-electric tubes; the interruption of either ray by a man or a child or even a little dog causes the door to remain open or if closing, to re-open. A similar device prevents game from escaping in a European national park. It would be a troublesome job to open and close the gate of the highway crossing the park. Therefore, instead of a gate several light rays cross the park exit and when interrupted relay a loud horn and switch on two coloured searchlight beams. The frightened game, whether stag or jack-rabbit, immediately turns back and never tries to break through that barrier of sound and light. Passengers may cut off this light and sound barrier for a short time when passing through the invisible gate. In a Washington park some time ago a similar automatic control had been set up where a bridle path crossed a highway, in order to allow equestrians to cross safely. First, it was tried out with one beam and one electric eye; that did not work because pedestrians passing in front of the cell caused the traffic light to operate, thus incessantly holding up the motor traffic; this difficulty was overcome by installing two such relays at the side of the bridle path, about three feet apart, arranged so that both would have to be affected simultaneously to operate the signal. A passing horse was large enough to do that but a pedestrian could not affect both electric eyes at once.

The Highway Commission of the State of California at many key points has installed electric eyes to count the number of vehicles passing over its highways. At each checking point two invisible light beams are thrown across the road. Whenever a vehicle breaks the ray another number is turned up on the mechanical counter at the roadside. The hourly totals are printed on paper tape, differentiating traffic moving in both directions. In most American tunnels and on important bridges similar counting devices are to be found.

Once a well-known American department store installed automatic photo-cell counters at all of its doors, checking accurately the number of customers entering the store at various times of the day. A

large gasoline company used the same method to determine the best locations for new gasoline stations. To verify where traffic was heaviest, automatic counters checked on the number of passing cars at every proposed location.

Even law-breakers may be trapped by the invisible tape between a light bulb and an electric eye. The Free Zone of the Staten Island Harbor of New York has been protected against smugglers by a chain of rays, reflecting mirrors and photo-cells, just as many houses have been defended against burglars and kidnappers. Another such device is used to convict speeding motorists: two electric eyes, spaced about half a mile apart and connected by an electrical circuit, measure exactly the speed at which your automobile is moving. If the velocity exceeds the legal number of miles per hour, the device switches on a red warning signal ahead of you, "You are driving too fast!" Then you had better slow down because if this warning is not heeded, a policeman will be sent in chase.

Opening of garage doors by the beam of the headlight was one of the first accomplishments of the then new electric eye. In Cincinnati's City Transportation Company's new garage there is an automatic car laundry where the electric eye does an even better job: one blink from the headlights and the magic photo-cell starts brushes rocking and water spraying to wash a bus in forty seconds.

It is humanly impossible to ride a bicycle in the groove of a street car track. But for an electric eye even the most incomprehensible becomes possible, as the "Phantocycle" proves, a riderless phantom bicycle developed in the Westinghouse research laboratories at East Pittsburgh. There is no better rider and balance keeper than the electric eye which steers this bicycle without a quiver along the narrow groove formed by three propulsion rollers. Steered and balanced by one photo-electric cell, that "bike" in a test run made 28 miles an hour and is able to maintain this pace for years, unsupported by wires or braces. It can easily bear a three-pound sideways push against its saddle before losing its balance and falling into its safety catch. The "beam ride" starts when a light beam strikes a mirror under the bicycle's pedals which reflects varying amounts of light toward the electric eye as the bicycle tilts from its upright position. The eye seems to sense the tilting, transforming the varying light energy into an electric

current which is amplified and delivered to resistances controlling a regulating motor. The motor steers the front wheel of the bicycle and moves two weights balancing it, the larger one attached to the front mudguard, the smaller one fastened to the



An Electric Eye is the only rider and balance keeper of this phantom bicycle, called "Phantocycle". The riderless bicycle makes 28 miles an hour and may maintain this pace for years without tilting. The Phantocycle looks like a toy but it has been developed to demonstrate the principle of a position regulating equipment employed in many industries.

handlebars and hanging over the front wheel. These stabilizing weights correct tilting just like a circus rider would balance a bicycle on a tight-rope by changing the position of his balancing pole.

This magic Phantocycle is not a mere toy devised by some playful engineers. On the contrary, it has been developed to demonstrate the principle of a position regulating equipment now employed in many industries and even military appliances, as in paper or steel sheet mills or in coast defence searchlights. For example, in the same laboratory there has been developed a photo-electric device which translates reflected light from a dark guide line on a paper roll into electric energy to control a reversible motor. The motor then maintains the position of the roller, holding the paper in

a straight path while a knife cuts it, thus making it possible to wind even rolls of paper or cellophane from uneven rolls and slit them in straight lines.

Another such electronic control permits cutting of paper bags from a printed roll, with definite relation to the position of printed labels or patterns, providing an accuracy of $1/32$ of an inch at speeds up to hundreds of feet per minute. The United States Army has adopted a device similar to that used in the Phantocycle to direct giant searchlights. These are so bright that an observer standing near-by is blinded. But by a suitable electrical connection he can direct the light beam from any distance, outside of the glare, simply by "aiming" a pair of binoculars mounted on a movable arm. Every movement of the binoculars sends an electric impulse to a regulating motor on the searchlight, and the motor and its balancing equipment aim the light.

Thus the electric eye provides control where mechanical contact cannot be made. The invisible light beam, travelling through space like the radio wave, causes a variety of reactions intended to help workers or to protect them. There are many machines in our factories on which a photo-electric device protects the worker from being injured. As soon as his hand gets into the machine's danger zone, it interrupts a light beam and the photo-cell closes a circuit which stops the machine.

The basic idea of all these photo-electric contrivances is always the same, whether the cell



Accounting departments of public utility companies, banks, etc., must handle and sort cards, bills, checks, by thousands daily. A photo-electric sorting machine reads the markings on such slips of paper in a fraction of a second and puts each in its proper compartment. The writing which the machine reads is not in letters but in a simple code of marks stenciled on the cards at the same time as the customer's name.

responds to a visible or invisible light ray and relays machinery for counting or automatic weighing or graduating for size or thickness; or whether the tube responds only to short-wave radiations for measuring the ultraviolet output of arc lights and sun lamps, as a recently developed apparatus does.

Transmission of light through thin material has also been measured by means of an electric eye, with more accuracy than any human eye is capable of. The eye has been used for matching the colour of transparent liquids such as oils, varnishes, lacquers, and solutions. The photo-electric comparator indicates, on a dial, the depth of colour of any sample in comparison with an arbitrarily selected standard. Electric eyes help to make perfect tin cans. In an American steel mill, a row of them watches a thin steel sheet racing 700 feet a minute on its way to become tin cans. The eyes not only see tiny pin-pocket holes as small as $1/64$ of an inch

across but they also operate a device to mark each hole. Being at least as sensitive as human eyes, electric eyes may record the slightest changes of light intensities. Cigars are being sorted automatically according to their colour. By the colour of heated material the eyes may determine its temperature, *e.g.*, by its redness the temperature of steel parts being heat-treated, within a preciseness of 25 degrees Fahrenheit.

Light changes lasting as little as $1/5,000$ of a second may initiate a control function by means of an electric eye. No wonder that this miraculous artificial eye has been introduced in modern sports where quickness and speed mean everything. Human eyes and hands are unreliable in timing to a fraction of a second, and thus modern electric timers making records of the start and finish in a race utilize electric eyes and light rays which are broken by the runners.

TRAINING IN MANAGEMENT OF RESEARCH LABORATORIES

In recognition of the rapid development of industrial research, combined with its growing importance in the national defence programme, the New York University College of Engineering will offer the first course in the country (U. S. A.) in research laboratory management. It is estimated that there has been a 100 per cent. increase in the number of research laboratories established since 1937. These facts have caused problems of management, administration, and accounting in a branch of industry which heretofore has been comparatively free of budgetary restrictions, operating policies, and administrative organization. This tremendous growth had demanded of industry that it seek men trained in administration, accounting, organization and management who have considered the problems peculiar to this new industry in the light of its unusual functions.

—*Journal of the Franklin Institute.*

Dissemination of Scientific Knowledge in India

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INDIA stands today on one of the lower rungs of the ladder of scientific progress and in the application of scientific knowledge to the solution of various problems—industrial, nutritional and so on. As in other countries, so in India also, it is necessary that a real understanding of science becomes “a part of the common life of our times” and “it is important to see that adult minds have the opportunity of appreciating what science is doing and how it is likely to affect human life”. To the application of scientific knowledge there is opposition from the people, due to ignorance, prejudice and superstition. Some people have a distrust for science because, as practised today, its progress means to them unemployment. All this is because the function of science is not properly understood. Dissemination of scientific knowledge on a much larger scale is necessary in India, because there is hardly any country in the world which needs the application of science more than India. The various agencies through which this can be achieved are the educational institutions, the press, the radio, the cinema, the libraries and the amateur science clubs.

EDUCATIONAL INSTITUTIONS

The educational institutions can very well help in this work by arranging lectures on scientific topics by members of the staff, as far as possible in modern Indian languages. The lectures should be simple and instructive and should be illustrated with lantern slides and experiments.

Popular scientific lectures in Gujarati and Marathi are arranged every week at the Royal Institute of Science in Bombay and the response so far has been good. People are interested in the lectures and appreciate them. Questions are asked at the end of the lectures and some would no doubt follow up the lectures by detailed reading if suitable

books were made available to them. This example should be followed wherever there are science colleges in India. It is not certainly too much to expect that the members of the staff would once in a week prepare a popular lecture for the public without a thought of remuneration. Another effort which can be made by such institutions is to hold every year scientific exhibitions. People seem to have a fancy for exhibitions and would flock to a scientific exhibition even if a nominal fee is charged to defray the expenses.

PRESS

The press can do valuable service in spreading scientific knowledge, especially in this country, where the financial condition of the people more often than not prevents them from subscribing to scientific journals and buying books on popular science. In spite of publishing sporadic articles, the newspapers should have a planned publication schedule, say a series of articles, on human biology, health and nutrition, production of necessities, communications (telephone, telegraph etc.) and so on. This can best be done by an adequate science news service, prepared by competent scientists and circulated to the press and wherever possible by the appointment of science editors, primarily journalists with a background of scientific training. Wherever this is not possible the press should get articles from the right type of persons,—those who know the subject properly, and not from those who have an incomplete knowledge and attempt to present a scientific discovery in a spectacular but often in a distorted manner.

RADIO

Radio is one of the potent weapons of educating the public. But unfortunately in this country one

finds hardly any systematic attempt at popularising science through this medium. There are occasional arrangements to broadcast scientific talks, but all these random talks will lead us nowhere. What is wanted is a well-planned and systematic arrangement. The radio stations seem to be filled up mostly with persons who have little or no idea of the advances in science and are not in a position to select important talks on scientific subjects, or do anything in the proper dissemination of scientific knowledge, although they may be doing admirable work in arranging entertaining talks on other subjects. There is a need of having competent persons trained scientifically to handle talks on scientific subjects, select the right persons to deliver such talks and arrange systematically to impart scientific knowledge to both children and adults, as far as possible in the modern Indian languages. The broadcasts should aim not only at mere imparting of knowledge, but should also appeal to the people to remedy the various defects in our living conditions by scientific methods. Radio is an important medium through which we can reach the villages and bring about a change in the living conditions and make them give up harmful practices.

Further, just as we have ordinary news service everyday, and every week a survey of the sport during the week on the radio, can we not have a weekly or fortnightly science news service when important events in the scientific world are reviewed—not necessarily of that particular fortnight, but of the past couple of months, compiled by gathering information from leading scientific periodicals? Such news may be broadcast only from one station in India and relayed by others. The value of such a review would be of course enhanced if arrangements are made to broadcast the same in modern Indian languages from different stations.

CINEMAS

The cinemas can play a useful role in the spreading of scientific knowledge. If our cinemas are not only to entertain but instruct, there should be a short feature of, say, about ten minutes before the beginning of the main feature, on some scientific topic, with a running commentary or suitable explanatory titles in the Indian languages. A start has been made in this country in the production of documentary films by some studios, but, such a movement must gain momentum. A comprehensive pro-

duction of such films has been started in Britain by the creation of the Scientists' Film Group which ensures the collaboration of a number of scientists in production. This might well be emulated in this country and we hope that the organisations which guide the destinies of film industry in this country will do the needful. It has been said that documentary films have no market in this country. If such films are made a regular feature in our shows the people will take a liking to them—a market will be created and the long talked-of educative value of the cinema will become a reality. For exhibition in schools, films workable on baby projectors shall have to be made and must be cheaply available. Messrs. Kodak & Co. are maintaining a library of such films at Bombay and Calcutta, but the films are in English. Still however they do serve a useful purpose; how much more would they be useful if such films were made available in some of our Indian languages.

LIBRARIES

Library facilities form another link in the chain of attempts to popularise science. The library movement in India is in its infancy and wherever public libraries exist they mostly contain novels, thrillers and other popular literary works, with the result that those who are interested in scientific books find it difficult to procure them. To a certain extent libraries can mould the public taste by stocking good books on scientific topics. The university authorities and the authorities of various educational institutions should open their libraries for use to the public, if not for the whole day, at least for a few hours of the day, say, in the morning or in the evening and if possible, on holidays.

AMATEUR SCIENCE CLUBS

Enthusiastic members of the community can form science clubs where discussion and even some actual work can be carried out and the members can exchange information on their hobbies like photography, astronomy, radio, gardening and so on. The contribution of amateurs to science cannot be denied, for, were not some of the greatest discoveries made by amateurs? Such clubs can arrange visits to laboratories, factories and places of scientific interest which is an important aspect of a real understanding of science. A recent issue of *Science*

contains an interesting note on how in America attempts are made to mobilise amateur talents. "To test the effectiveness of the work on the part of amateurs as well as to bridge the gap between the general public and pure research has been the purpose of a programme in the Philadelphia area conducted by the Committee on Education and Participation in Science under the supervision of the American Philosophical Society. A series of programmes have been carried out by the Committee, whereby amateur scientists in Philadelphia area working on a voluntary basis, are making original observations and compiling data in the fields of botany, climatology, physics and radio and zoology under the supervision of professional scientists. In botany, laymen observers have been engaged in phytophenological studies. They have recorded in a systematic form the opening of petals, the shedding of pollen and the maturing of fruit of some 115 of local spring and summer wild flowers In the field of radio, amateur operators who agree to co-operate, fill out charts with technical information concerning receptions, fade-out, skip distance records and data obtained in the course of their normal contacts. In the field of zoology, amateur naturalists have made intensive local studies of reptiles, amphibians and insects by tagging or otherwise marking them and studying their feeding, growth, maturing and other habits. . . . The volunteers represent dwellers in urban and suburban communities with varied occupations and interests including business men, stenographers, engineers, housewives, teachers and others."

BOOKS AND JOURNALS

All attempts at popularising science must be backed up by the publication of good and cheap books on scientific subjects in modern Indian languages. An ideal method would be to have an all-India body which would invite people whom they think competent to handle particular subjects to write short popular books on the same, for certain fixed remuneration, either in English or in the mother tongue of the person concerned. They can then be translated into different Indian languages. In the absence of such a body the various educational societies should take up the same task locally for each linguistic province. They should at the same time try to get translated any useful book written in a language other than their own. These books

should be as cheap as possible. The various six-penny publications in English are serving a useful purpose in the propagation of knowledge. A low sale of books in modern Indian languages is bound to affect the price, but then, it should be seen that there is no undue increase in cost due to extravagance in production. The sale of books of a scientific nature in the Indian languages will be limited unless the appeal of science becomes more wide-spread, but, is it not also true at the same time that unless there are good books available in our own languages the appeal of science will never become wide-spread?

The same applies to popular science journals. The enormous number of popular science journals in English are an indication of the fact that laymen are interested in scientific topics. There is indeed scope and need for having at least one such journal in each of the modern Indian languages.

WORK FOR OUR STUDENTS

Can we not in this country make a beginning? Here students can do a good deal of work. If students, especially those studying in colleges, are instructed properly in the collection of data on specific subjects, they can do this work in their vacations, and as some of them go to their native places on holidays, a good deal of data on, say, the type of food consumed, indigenous medicinal and other plants, mode of agriculture and so on can be obtained for different parts of the country. The same students with adequate instruction in dietetics, agriculture, common diseases like malaria and so on, may be able to impart this knowledge to the people in their native places and if such an attempt is made by all the educational institutions in India, much can be done. If only the people at the top are less apathetic and give a direction to the students! By this method it will be possible to a certain extent to speed up the dissemination of scientific knowledge in the villages which is very important. Villages at the present day form the backbone of India, and from here the resistance to scientific method of approach is greater, because superstitions and prejudices reign supreme. If therefore in our efforts we cannot touch the villages, we shall not be able to do much. It is only by the enlightenment of people who form a link between the city and the village that this knowledge can be effectively transmitted to the villages. The other method of touching the villages by means of broadcasts has already been mentioned.

WORK IN OTHER COUNTRIES

It will not be out of place here to see how the scientific outlook is cultivated in the U. S. S. R. This has been briefly summarised by Dr Ruhemann in a note. Some of the striking measures he mentions are as follows* :—

(1) Great attention is given to natural science in the schools and scientific reasoning is everywhere applied even in school subjects not strictly involving natural science.

(2) The "Pioneer Houses" (children's clubs) are equipped with excellent science laboratories and exhibits, and the children are encouraged in every way to develop scientific interests.

(3) Every Soviet newspaper prints leading articles on scientific and technical subjects and the results of science and engineering are front page news. The production figures of the leading industries, coal, ferrous metals, transport and motor bus are published daily in the central and local press, and are keenly studied by the public who know very well that all the amenities of their daily life depend on these figures.

(4) Well-stocked scientific and technical book-shops are as frequent in Soviet towns as tobacconists are in London. The books are good and cheap and every one buys them. Every factory and every State and collective farm has an extensive library of popular and advanced scientific and technical literature.

(5) Every one who is interested in scientific knowledge has ample opportunity to develop it. He may pass from the elementary school to the factory school, from here to the workers' evening school and thence to the University or technical college without paying a penny, simply by passing the examinations in which each course of education culminates. The directors of the organisations at which the man or woman is working are obliged to give them every chance of improving their knowledge.

(6) In every factory all employees are obliged to attend the classes at which the particular branch of industry in which they are engaged is expounded and discussed, including the scientific facts on which the process is based. Wages are adjusted to the results of these examinations which are repeated at

regular intervals. In 1935, 797,000 workers, administrative functionaries and economists went through these courses alone in the Commissariat of Heavy Industry. In 1937 the number was much greater.

(7) The Stakhanov movement (named after an enterprising young miner who succeeded in rationalising his work in the pits, and whose lead was followed by many thousands of workers in all branches of industry and agriculture) is actively encouraged by all those in authority. Any form of rationalisation brings immediate emolument to the workers and every "Stakhanovite" is entitled to particular facilities for increasing his knowledge and broadening his outlook.

Other countries in the world are also taking steps to bring about a proper understanding of science and show what it can do for humanity. In France, eminent scientists discuss their problems with working class audience in the workers' university and help to dispel the misunderstandings and prejudices which have grown up against science.

In Britain, the Trades Union Congress has set up a scientific advisory committee constituted of equal number of scientists and representatives of the T. U. C. to discuss the questions of food and agriculture, occupational diseases, population and vital statistics, defence and aviation and many other scientific problems.

TASK BEFORE US

It has been the experience of many who work for making the appeal of science wide-spread in this country that people are apathetic and this has been advanced as an argument by some for not doing anything. This, on the contrary, is an argument for making stronger efforts to rouse public interest and bring about an awakening, because unless we in this country take to science in a greater degree we will never be able to go along with a swift-moving world. India cannot afford to remain static in a dynamic world. With enormous potentialities for scientific development in our country one sees no reason why so many of the few M.Sc.'s and Ph.D.'s and other technically qualified persons produced by our universities, young men with talent and enthusiasm for work, are either without jobs or are working at odd jobs on meagre salaries—with the menace of hunger ever hanging over their heads.

* Quoted from Appendix VII of the book 'Social Function of Science' by J. D. Bernal.

Before closing this article I cannot resist the temptation of quoting here a part of the eloquent appeal made to France by Pasteur, because it is applicable to this country. He said: "If conquests useful to humanity touch your heart, if you stand amazed before the surprising effects of electric telegraphy, the daguerreotype, anaesthesia and so many other admirable discoveries; if you are jealous of the part your country can claim in the further flowering of these wonders—take an interest, I urge upon you, in those holy dwellings to which the expressive name of laboratories is given. Ask that they be multiplied and adorned. They are the temples of the future, of wealth and well-being. It is there that humanity grows bigger, strengthens and betters itself. It learns there to read in the works of nature, works of progress and universal

harmony, whereas its own works are too often those of barbarity, fanaticism and destruction." Will this appeal not find an echo in the hearts of our rich countrymen?

Some in India are working towards the end outlined in this article and it is a pleasure to acknowledge the fact. May be that some others are planning to do the same, but, still much remains to be done and in a systematic manner.

Let us hope that all those who love India and have its interests at heart will play their part, in the dissemination of scientific knowledge and in sustaining scientific research and applying the results to the welfare of the people, so that tomorrow will rise a new awakened India.

Annual Report of the Imperial Council of Agricultural Research for 1939-40

THE Agricultural Research Council's report for 1939-40 gives a review of the progress of agricultural research schemes undertaken during the year and in immediately preceding years. From the inception of the Agricultural Research Council it had solely to depend on annual discretionary grants from the Central Government. The financial position of the Council was thus quite insecure and it was not possible to plan and execute long term research programmes. To remedy this defect and to give the Council a stable financial footing the Government of India introduced in the Central Legislative Assembly, the Agricultural Produce Cess Act, in March 1940 which was duly passed and received the assent of the Governor-General. The Act provides for levying a cess of $\frac{1}{2}$ per cent *ad valorem* on a number of agricultural exports. This will yield an income of about Rs. 14,00,000 in a normal year and the whole amount will be spent up in agricultural research schemes. The Council is thus ensured of a larger and more stable income unaffected by the financial vicissitudes of the Central Government.

The report deals with the activities in various centres in connection with the Council's rice research schemes. As a result of Sir John Russell's recommendation the Council accepted the principle of limiting its assistance to work on rice genetics, water requirements and manurial experiments leaving rice breeding to be tackled by provincial Governments. This policy has been generally followed. Efforts are being made in different parts of India to evolve varieties of rice suited to local conditions of growth, such as varieties which will stand salt acid and flood, or would grow at an altitude of between 2000 and 5000 feet.

The preservation of fruits and vegetables by cold storage has received the attention of the Council for the last few years. In Bombay, cold storage trials have been made with practically all the important fruits and vegetables grown in India and their suitable cold storage temperatures have been ascertained.

Experiments on an American variety of tobacco, *Bonanza*, have shown that it is a suitable variety of

cigarette tobacco for India. As decided by the Council in 1939 a tobacco officer was sent out for training in the United States of America, Canada, Japan, Singapore and Ceylon. Two other officers will be sent to U. S. A., in 1941 for studying different aspects of tobacco cultivation viz., cultivation, curing, grading, re-drying and reconditioning, packing and storage etc.

The Council initiated a standardized pure-line trial of groundnuts at 27 different stations throughout India. Three new species of potatoes collected by the Empire expedition to South Africa and Mexico were received in Simla and used for trials in this country.

Dry framing research throughout India is now being conducted on a common programme. The main line of work is agronomic, which will enable workers to evolve a system of farming capable of securing a crop even in a year of drought.

A large number of medicinal plants were chemically and pharmacologically analysed during the year, and pyrethrum was tested for its value as an insecticide. A monograph on the poisonous plants of India has been published. A large amount of information relating to the distribution of medicinal and poisonous plants has also been collected.

To give effect to the recommendations of Mr A. Wilson, who was appointed by the Council to enquire into the prospects of increasing cinchona cultivation in India, the Council is considering a scheme of

research providing for two research stations—one in the North and one in the South. To each of these stations a State nursery will be attached. These research stations will carry out a comprehensive programme of research and investigate the immediate problems of cultivation. The State nurseries will supply planting material to new concerns and test plots in selected areas will be laid out to determine the suitability of land for growing cinchona.

The central fodder and grazing committee of the Council considered during the year schemes on mixed farming from a few provinces and recommended a standard scheme capable of application throughout India, with modifications to suit local conditions.

A comprehensive scheme for an all-India soil survey is now under the consideration of the Imperial Council of Agricultural Research. The crops and soil wing of the Board of Agriculture and Animal Husbandry passed a comprehensive resolution for co-ordinated action in the provinces and States to check the menace of soil erosion in India.

The Council's bi-monthly journal *Agriculture and Livestock in India* is appearing as a monthly magazine under a new title *Indian Farming* from January 1940. This magazine publishes the latest news of agricultural and veterinary research and new developments in theory and practice of farming. It aims to present a picture of research and developments in agriculture and animal husbandry in India.

The National Academy of Sciences, India

TENTH ANNUAL SESSION AT DELHI

THE National Academy of Sciences was started in 1931 with its seat at Allahabad ten years ago at the suggestion and initiative of Prof. M. N. Saha who was then at Allahabad. An interesting account of the foundation of the Academy and its main objects will be found in *Nature* of October 8, 1932, and in the leading article in *Nature* of September 23, 1933. The tenth annual session of the Academy was held this year at Delhi from the 22nd to the 24th February. The Hon'ble Sir Maurice Gwyer, K.C.B., K.C.S.I., chief justice of India and vice-chancellor, University of Delhi, inaugurated the session, and it was presided over by the Hon'ble Sir Shah Sulaiman, D.Sc., F.N.I., the president of the Academy. The sectional presidents were Dr Sir Santi Swarup Bhatnagar for the section of physical sciences, and Rao Bahadur B. Viswa Nath for the section of biological sciences.

A local reception committee with L. Shankar Lal (of the Delhi Cloth Mills), senior vice-chairman, Delhi Municipality, was formed to make arrangements for the Conference. The delegates who came from different parts of the country numbered about fifty, and stayed mostly with local friends and in the Delhi University buildings. All the meetings were held in the University.

The session which was held in the University Hall began with the welcome address by L. Shankar Lal, who expressed the hope that one day 'Delhi may be a sort of scientific Kashi to which every mind anxious for enquiry may turn with hope, faith and profit'. Sir Shah Sulaiman, gave his presidential address on 'Dilemma in physics'. The address of Sir Maurice Gwyer was very stimulating, and he expressed his fervent desire to see the University of Delhi at no distant date occupy a position worthy of the capital city of India. Dr Bhatnagar's address was on 'The present position of scientific research in Indian universities and industries'; and the subject of Rao Bahadur Viswa Nath was 'Recent develop-

ment in the science of plant and animal nutrition and their significance to national nutrition and health'.

In the afternoon the delegates visited the transmitter of the All India Radio, and were entertained to tea by chief engineer, Mr C. W. Goyder, and other members of his staff.

The separate sectional meetings were held on the 24th, and about thirty papers were read and discussed in the two sections. Special mention may be made of the two demonstrations, one of a self-acting siphon and the other of a student-type electron-diffraction camera, given by Dr P. K. Kichlu of Lahore.

A most interesting evening lecture on uranium fission was given by Prof. M. N. Saha, who had specially come from Calcutta for the occasion. Another popular lecture which was much appreciated was on cosmography by Prof. A. C. Banerji of Allahabad.

The delegates visited the Imperial Institute of Agricultural Research on the 23rd afternoon and were taken round the various departments and given an opportunity to acquaint themselves with the researches in progress. In the evening the members of the Institute were 'at home' to the delegates.

Undoubtedly, the outstanding social function in connection with the conference was the dinner by Sir Shri Ram and Lala Shankar Lal at their residence on Sunday night to meet Sir Maurice Gwyer, and the president and the delegates to the conference. More than 200 covers were laid.

The Delhi session proved very successful, worthwhile and enjoyable, and this success is to be largely attributed to the keen interest taken by Sir Shah Sulaiman at all stages of the organisation, to the authorities and staff of the University of Delhi and to the generous help and co-operation they received from the Imperial Institute of Agricultural Research.

Reclamation of Alkali Lands

S. P. RAYCHAUDHURI

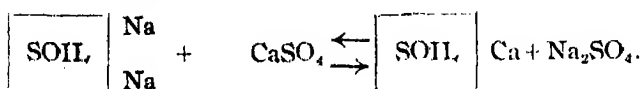
Chemical Laboratory, Dacca University

ALKALI lands are characterised by the presence of an excess of sodium salts or by the predominance of sodium among the exchangeable bases. Sodium clay is rather impervious to air and is very sticky. It is thus very difficult to work with. Moreover, sodium clay easily hydrolyses, giving to the solution an alkaline reaction which is unfavourable for the growth of most plants.

The chief defects of alkali lands are: (i) high alkalinity (the pH is sometimes as high as 10.8), (ii) low nitrogen content, (iii) high impermeability, (iv) difficulty in settling readily when shaken with water, (v) absence of bacterial activity, and (vi) deficiency in organic matter.

Reclamation of such unproductive sodium soils consists in converting it into calcium soil which is the normal agricultural soil. This is frequently done by the application of gypsum or lime.

The chemistry of the change in the nature of sodium soil complex on the application of gypsum is as follows:



For the conversion of sodium soil into arable calcium soil, three stages can be differentiated:

- (i) Treatment of the soil with gypsum so as to convert the sodium absorption complex in the soil into calcium absorption complex.
- (ii) Removal of the sodium sulphate formed during the exchange and exclusion of all supplies of sodium salts.
- (iii) Neutralisation of the alkalinity of the soil.

WORK IN OTHER COUNTRIES

T. S. Dymond and his colleagues in England (1897-99) obtained some interesting results in the

reclamation of soils spoilt by sea water. They showed that the first effect of flooding the land with sea water was to kill the vegetation by the direct action of the oceanic salts. But when the flood subsided and rain water began to wash away the salts, it was found that the soil which was formerly in a remarkably good condition from agricultural point of view, gradually became difficult to work with and was hard in dry weather. Dymond showed that the effect of the sodium chloride was to displace calcium and the magnesium from the clay, the places of calcium and magnesium in the clay complex being taken up by the sodium.

The above observations of Dymond are similar to those of Hissink and his collaborators in Holland who successfully carried out extensive reclamation of soil damaged by sea water in the Zuider Zee area. They have shown that the soil, left after the rain water has drained away, is unfertile because it contains sodium clay, and in order to make it fertile it must be converted into calcium clay. The Dutch investigators have shown that the soil in the Zuider Zee area contains sufficient reserve of calcium salts for the conversion of sodium clay into calcium clay, although, the operation takes some time. The scheme of reclamation of Zuider Zee area consisted of the following operations:

- (i) Construction of a dam mainly made of boulder clay, between Wieringer in North Holland and Friesland. From the lake so formed, four large areas of land called 'Polders' have been recovered. The central part forming the deepest portion of the lake remains under water and forms the Yssel Lake, extending over 270,000 acres, its surface being 16 ft. below normal sea level.
- (ii) Draining of polder by means of rainwater with the help of suitably dug drains and canals.

(iii) Provision for navigation due to the enclosure in Zuider Zee by erecting suitable locks in the polder.

(iv) Construction of suitable roads and bridges in the polder.

As has been already said the Dutch soil contains a reserve of calcium, and nothing more is therefore needed for reclamation, excepting adequate drainage, so that the sodium chloride can be washed out from the soil. Adequate cultivation and cropping of the soil is then necessary so as to produce carbonic acid which brings the calcium in solution which then reacts with the soil complex forming the calcium clay. Cultivation in such reclaimed areas are usually shallow, since deep cultivation would bring up wet soil containing much sodium clay or sodium salts. The process occupies nearly a period of four years after which the Dutch farmers begin their cultivation. The crops grown in such reclaimed areas are usually rye, barley, and sugar beet.

In the United States co-operative reclamation began in 1850. In the entire country 56,763,751 acres have already been drained with fruitful results.¹ In parts of the United States powdered sulphur at the rate of 20-30 cwt. per acre has been used with beneficial results for the reclamation of alkaline soils. By the joint action of bacteria and light, the sulphur is oxidised in the soil forming sulphuric acid, which neutralises the alkali present in the alkali soils. Ammonium sulphate has also been used. This reacts with calcium carbonate forming calcium sulphate, which can be washed away by flooding.

The reclamation of Hungarian alkali soils has been carried out by de' Sigmond. The soils containing sodium salts are reclaimed by reducing the evaporation from the surface of the soil and by growing lucerne, which requires large amounts of moisture and dries up the soil. In this way the upward movement of the salt is decreased. Press lime, gypsum, farmyard manure etc. have also been used in dissolving the calcium carbonate.

WORK ON INDIAN LANDS

Vast tracts of unproductive lands occur in various parts of India, particularly North-West Province, in Bihar and in south of India. In the United Provinces alone it comprises more than 4,000,000 acres. These waste lands are commonly

known as *Usar* lands. In the Punjab, Bihar, Mysore, Sind, Bombay and Madras Presidencies, there are large areas of such unproductive lands. There are also large tracts of lands damaged by sea water, in Bengal. Indeed, the amount of alkaline lands is increasing in India rapidly. In Sind and other parts of this country, normal soils are being converted into alkaline ones by the washing away of the soil due to irrigation.

As early as 1874, the Irrigation Department of the North-West Provinces tried to reclaim *Usar* lands and in 1877 a 'Reh' committee was appointed to investigate into the problem. Subsequently experiments² were started at Awa in 1879, at Cawnpore in 1882 and at Aligarh in 1885.

Dalip Singh and Nijhawan³ have studied the *Kallar* soils at Lyallpur, Lola Kaku, Montgomery, and Bara Farm in the Punjab. They have reported that the alkaline soils available in these parts contain 0.63-1.07 per cent of soluble salts in the first four feet. These authors have observed significant improvement of the texture of these alkali soils, by treating them with a mixture of calcium chloride and calcium sulphate.

Leather tried to reclaim *Usar* fields near Aligarh and other parts of the United Provinces by applying gypsum. His results demonstrate that soils containing 0.008 per cent to 0.082 per cent sodium carbonate, even when treated with gypsum, is not suitable for the growth of Wheat (cf. J. W. Leather, *Investigations on the Usar Lands of U. P.*, in Allahabad, 1914, p. 37). In recent years Dhar⁴ has suggested that in the reclamation of alkali soils of the dry tracts of Northern India, molasses can be very usefully applied. Molasses is composed of between 60 to 70 per cent. of carbohydrates, 0.5 per cent potash, 2 per cent lime, 0.5 per cent phosphoric acid, 0.5 per cent combined nitrogen, 0.5 per cent silica, 0.5 per cent iron and aluminium oxides and the rest water. The lime contained in the molasses which is added to the soil, is rendered soluble by the organic acids formed from molasses and is helpful for the conversion of sodium salt into the calcium one. If very large quantity of molasses could be used, say 500 to 1,000 mds. per acre on the alkali soil, plants could be grown in such soils, six months after the application of the molasses. In

¹ N. R. Dhar's Presidential Address, National Academy of Sciences, Dec. 1935.

² *Ind. Jour. Agr. Sci.*, 2, 1, 1932.

³ *loc. cit.*, pp. 40-42.

⁴ W. W. Weir, *Soil Science*, p. 206, 1936.

connection with this proposed scheme for soil reclamation work in India, Dhar points out that there is an additional advantage in the application of molasses to the soil in that the contents of ammonium salts and of total nitrogen in the soil are increased. This is caused by the energy set free in the oxidation of carbohydrates of the molasses which is utilised in the fixation of atmospheric nitrogen in the soil. The oxidation of the carbohydrates in the molasses lead-

with press mud, the pH becomes much less and the alkali soils completely coagulate, showing increasing permeability and flocculation of the particles.

Oil cakes containing about 5 to 7 per cent nitrogen, oils and cellulosic materials, have been found to neutralise the alkalinity of bad alkali soil. Hence oil cakes should also be suitable as reclaiming agents (*cf.* N. R. Dhar, Presidential Address, National Academy of Science, India, January, 1937).

PRODUCTION AND IMPORTS OF MOLASSES INTO INDIA

	PRODUCTION			AVAILABLE FOR CONSUMPTION		
	Vacuum pan Factories	Khandsaries	Total	Imports	Total	Excluding Khandsaries
	Tons	Tons	Tons	Tons	Tons	Tons
5 years preceding war	30,000	50,000	80,000	93,354	173,354	123,354
1930-31	68,645	200,000	268,645	102,024	370,669	170,669
1931-32	115,808	250,000	365,808	40,191	405,999	155,999
1932-33	186,658	275,000	461,658	31,991	493,649	218,649
1933-34	230,154	200,000	430,154	2,401	432,555	232,555
1934-35	255,817	150,000	405,817	415	406,232	256,232
1935-36	369,028	125,000	494,028	...	494,028	369,028

CONCLUSION

Thus two factors are very essential in any scheme of soil reclamation :

- (a) Proper application of lime or any suitable calcium salt.
- (b) Land irrigation and drainage.

To the above factors may be added the process of manuring, cultivation and cropping.

For proper irrigation, the question of origin of alkaline and saline soils is of the greatest importance. Very frequently irrigation causes the ground water to rise, bringing sodium salts to the surface levels. This causes replacement of calcium by sodium in the absorbing complex. Indeed, not much attention has been paid so far to the deterioration of soils by irrigation.

ing to nitrogen fixation can be effected through the agency of bacteria, sunlight, inductors, and catalysts like iron, copper, manganese and titanium compounds. These observations of Dhar have been confirmed at some Indian agricultural stations. If these observations be found to be generally applicable and if the question of transport of molasses to the fields be solved satisfactorily, a new chapter in Indian agriculture will be opened up. Indeed the proper disposal of all the molasses which are annually produced from the numerous sugar factories in India is a very important problem. The above table regarding the import of molasses in India, quoted from the report of E. J. Russell will be interesting in this connection.

From 300,000 to 400,000 tons of press mud are being annually turned out by sugar factories in India. This substance containing calcium salts, carbohydrates and nitrogenous compounds are practically wasted. Dhar has shown that when bad alkali soils are mixed

Philosophy of Rural Reconstruction in China*

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RECONSTRUCTION in its broader aspect arises from the impact of Science upon Society and the necessity for social reorganisation from paleo-technique empiricism to neotechnique experimentalism followed by orderly social control. The narrower aspect is in the sense of overtaking the lag between the 20th century science and its immediate utilisation for human welfare in unindustrialised agricultural society. This latter is the topic under discussion.

Rural reconstruction in China may best be made comprehensible by summarising the major differences between it and reconstruction in India. Chinese organisation is the result of three factors that must be explained to understand the differences. First is the 20 years of field experience and lessons learned. Second is the extension into the communities of the research and training interests of certain leading Chinese universities to develop the methodology of successful reconstruction and to train in these methods the senior staff requisite for administration. Third, the policy of reconstruction, particularly of the universities in question, is based upon defined principles whose acceptance must constitute the point of departure in planning for reconstruction if it is to be either significant or successful. This address discusses reconstruction under the three major designations referred to of experience gained, university participation and the underlying principles now accepted.

HISTORY

Rural reconstruction in China developed in the years between the end of the Great War and 1937. This period had two chapters—the first of empirical hit-and-miss methodology lasting till 1934 and the second, a period of systematic planned reconstruction based upon enunciated principles. The earlier period had a number of separate efforts very similar and corresponding to those observable regionally in

India today. It is unnecessary to report the majority of these on account of their non-reproductiveness and consequent insignificance in determining the main course of evolution. The main movement centres around a single individual J. Y. C. Yen.

Mr Yen proceeded immediately upon graduation in the Yale University to the Chinese Labour Corps in France during the war as a Y. M. C. A. secretary. His imagination was aroused by the almost complete illiteracy of the several lakhs of his countrymen recruited chiefly from Shantung province and this resulted in his initial efforts in adult education through evolving a basic vocabulary. This war interest led upon his return to China to the establishment in 1921 of the National Association of the Mass Education Movement; and, the circumstances were such that the Movement became nation-wide within a short space of three or four years, particularly in urban areas. During this period the Movement enlisted the co-operation of scholars to determine the most efficient basic vocabulary of 1,000 Chinese words that could be learnt by the young-adult in a series of lessons covering three months. The beginnings also were made of the requisite literature to implement the basic vocabulary. And, during this period several provinces were stimulated to establish departments of mass education. The predominantly rural character of China directed Mr Yen's attention towards the agricultural population. Professors of agriculture, mostly trained abroad, were enlisted to prepare the requisite follow-up literature. However, it was found that the material was so far removed from the realities of the problems of the farmer as to be almost useless in interesting him. This led the Association to establish a rural branch in Tingsien about 100 miles south of Peking, where a few agriculturists settled down to determine through experience what were the real agricultural problems of North China. Mr Yen was soon forced to the conclusion that no single social field of application of knowledge could progress very far in so backward a community without the concurrent establishment of other fields. He consequently turned for help to the

* Adapted from the address delivered before the Royal Asiatic Society of Bengal, on March 7, 1941.

respective university experts in and around Peking, which still was the capital as well as the educational centre of the country. It was this realisation of the necessity for a co-ordinated solution of the problem and the manner whereby Mr Yen was able to enlist the interest and enthusiasm of academic experts which laid the foundation for the planned reconstruction that evolved during the next decade.

It was during this decade after 1925 that 'reconstruction' methodology was experimentally developed in Tingsien in education, agriculture, public health, etc. based on the economic practicability and social conditions of North China. Both the national and the provincial governments gave official status to the Association's work in Tingsien originally established for mass education whereby the Association was given control of the local Government through its ability to nominate the magistrate of the sub-division having approximately 4 lakhs of population. In the meantime, Mr Yen solicited funds for support of the work from private channels in China and returned from a trip to the United States with contributions of (£100,000) five lakhs of dollars to support the veritable social laboratory utilising more than 100 technical workers which had gradually been established. The success of Mr Yen prematurely attracted hundreds of officials and others from all parts of China to an extent that the railway authorities had to make special provision for the number of visitors who also seriously hampered routine activities. This prematurity of interest was dangerous through the discredit resulting from efforts made by many upon their return to their own localities to reduplicate what they had observed in Tingsien without having grasped the technical implications and, more important, lacking the trained technical personnel to undertake reconstruction.

The single most important result from Tingsien probably was the manner in which certain universities in and around Peking were stimulated to extend the responsibility and scope of their social disciplines beyond their academic walls into the community. This resulted in the appreciation that the social sciences, as much as the natural sciences, are not taught to but must be learnt by the students through opportunity for self-participation in community exemplifications of the principles presented in the class-room. Consequently, undergraduate students were sent to Tingsien under their instructors. Thus, in medicine the fourth year students had three weeks' rural added to their previous urban 'clerkship' in

public health, during which time opportunity was afforded for some participative experience in addition to general orientation in rural reconstruction as a whole through demonstrations provided in each field. This development of university interest coincided with the growing national demand for reconstruction that experience proved could be successful only if based upon effective methodology and personnel trained in such methodology. The natural outcome of this university interest was the establishment of a formal organisation in 1936 designated the North China Council for Rural Reconstruction, consisting of five universities, the Mass Education Movement, and the Shantung provincial Government. The purpose of the Council was stated to be "a correlated community programme of rural reconstruction through which controlled field facilities and services for applied training and research in the social sciences may be made available to its constituent institutions and to provide personnel of high quality to the various enterprises for social reconstruction in China which now are in so great need of trained workers." The Council functioned through a Rural Institute which carried on instruction and research in the applied social science of civil administration, economics, social medicine, education, agriculture and engineering. The Council was given political control by Government of the first administrative area of Shantung province possessing approximately 10 million population. The Institute as the joint representative of the Council, universities and the Government possessed the authority to operate the constituted community facilities through power to nominate its personnel to the official government posts of the area. 'The universities' departments as such lost their individual identity in the field and functioned solely through the Institute as their co-ordinating agency. Faculty members resided in the field. Within this area the Council through its Institute designated one sub-division of 5 lakhs of population as its intensive experimental-demonstration field. The Institute consisted of two divisions: (a) the community service division responsible for the routine administration of the area, composed of the heads of instructional departments together with the chiefs of the sections or bureau of government, whereby teachers from the universities were concurrently appointed as government officers (b) the educational-research division composed of the heads of departments of instruction, and it was this second division which dealt with all matters relating to the educational and scientific policy of the Institute and whereby its representatives

on the community service division was able to control and modify governmental administration in terms of its educational and scientific needs. Planning was done in the first instance by the Institute for subsequent approval by the Council and finally by the provincial Government. The annual budget of the Institute, apart from routine civil administration expenses, was approximately 4 lakhs of Chinese dollars.

The Council and its Institute were inter-linked by means of either its Council or Institute representatives serving on various boards and committees of National Government and advising the latter's policy on the one hand, while Government in turn was represented on the Council and was able to guide Institute policy in terms of the realities of governmental administration. A Rural Reconstruction Committee of the National Economic Council of the Government was established at Nanking to co-ordinate the different fields of government and corresponding to these represented in the Council's Institute.

The Colleges of the participating universities drew up syllabi for their departments to take advantage of such a controlled community and requiring the residence in the field for several months of the undergraduate during the last year of instruction. Students were given a brief horizontal introduction to the several co-ordinated fields of social function before 'clerking' vertically in their specific subject. Special facilities were also designed to permit of a limited number of graduate students in each of the social fields. However, any international consideration of China requires the bearing in mind of certain facts relating to the time when a modern government was established. Although the Revolution took place in 1911, it was 1927 before the Nanking Government inaugurated civil administration in the modern sense. The chief cause for the non-implementation of the 1911 Revolution was the absence of technical personnel. The first university was established as late as 1906, the first medical college in 1913 and other technical colleges even later. Consequently for successful Rural Reconstruction next to solving the problem of proven methodology, it was considered necessary to establish provincial institutes of public administration to provide personnel of a vocational level. It was to train the teachers for the latter that the University Council Institute set as its instructional task because it was obvious that reconstruction would continue in name only until provided with modern social servants

competent to initiate and to supervise the utilisation of modern knowledge in the daily lives of the people. Also by 1937, Reconstruction in China had reached a stage where an acute problem had arisen to protect the movement from being discredited through unsuccessful results of hurriedly created provincial bureaux lacking the essentials here described, particularly methodology and personnel. At this point it becomes necessary, in order to interpret the Council in its true perspective to comprehend both the background of sociological thought common to the constituent members of the Council, as well as the general social-economic level of rural China. The following representation of the philosophy must be understood as one's own recollection of the numerous references which were in circulation between the various senior members of the Council and the innumerable hours of evening discussions that occurred in the quiet rural atmosphere of originally Tinghsien, and later Tsining, the seat of the Institute in Shantung.

UNDERLYING THOUGHT

Historians and scientists agree that society is in a major transitional epoch corresponding in its revolutionary character to the two major ones previously experienced by mankind, viz., the period of the proletariat culture to the dawn of history when society was founded and, the ancient civilisations were established. This second period continued until the present transformation of society began 300 years ago with the European Renaissance. Social reconstruction to be intelligent or rational implies planning. Planning is obviously inadequate unless designed in relation to the eventual social scheme as a whole. The trend of the present transitional period of social organisation can be defined only in terms of the past and knowledge of differences in the present resulting from new factors which have arisen. Social thinkers previous to the present century expressed ideas on society which increasingly are now becoming accepted fact. Thus Rousseau defines the Social Contract of Society as: "That form of association which will defend and protect with the whole common force the person and goods of each associate; and in which each, while uniting himself with all, may still obey himself alone and remain as free as before." John Stuart Mill in *'On Liberty'* clearly foresaw what is today the world's crisis when he defined the biological basis which social law must evolve towards in respect to individual freedom of liberty: "Whenever in

short there is a definite damage or a definite risk of damage either to an individual or to the public, the case is taken out of the province of liberty and placed in that of morality or law." Herbert Spencer in his *'The Data of Ethics'* defined the conflict between collective and individual cultures long before the present crisis arose proving the truth of his diagnosis: "But here we are met by a fact which forbids us thus to put in the foreground the welfare of citizens, individually considered, and requires us to put in the foreground the welfare of the society as a whole. The life of the social organism must, as an end, rank above the lives of its units. These two ends are not harmonious at the onset; and, though the tendency is toward harmonisation of them, they are still partially conflicting. As fast as the social state establishes itself, the preservation of the society becomes a means of preserving its units. Living together arose because, on the average, it proved more advantageous to each than living apart; and this implies that maintenance of combination is maintenance of the conditions to more satisfactory living than the combined persons would otherwise have. Hence, social self-preservation becomes a proximate aim taking precedence of the ultimate aim, individual self-preservation. This subordination of personal to social welfare is, however, contingent, it depends on the presence of antagonistic societies. So long as the existence of a community is endangered by the actions of communities around, it must remain true that the interests of individuals must be sacrificed to the interests of the community, as far as is needful for the community's salvation. But if this is manifest, it is, by implication, manifest, that when social antagonisms cease, this need for sacrifice of private claims to public claims ceases also; or rather, there cease to be any public claims at variance with private claims. All along, furtherance of the individual lives has been the ultimate end; if this ultimate end has been postponed to the proximate end of preserving the community's life, it has been so only because this proximate end was instrumental to the ultimate end. When the aggregate is no longer in danger, the final object of pursuit, the welfare of the units, no longer needing to be postponed, becomes the immediate object of pursuit".

Today, it is universally acknowledged that the determining force which shapes society is Economic. The essential factor determining Economics is "Energy". Machine energy is synonymous with the Industrial Revolution has been clearly analysed by

Stuart Chase in *'Technocracy: An Interpretation'*. Chase advances the conception of Energy magnitudes being the condition governing political and social institutions. The present emerging third stage was preceded by two earlier stages. Primitive communities had worked primarily by virtue only of the food eaten by their members converted into physical power of human muscle. The chief engine was the human being and his available energy determined the standard of living of the community and its social institutions. This power of the human engine is measurable by its food intake and is equivalent to 2000 kilogram calories per capita per day and this was the sole energy during the first period of man. The second period originated with the early civilisations when the domestication of animals and crude water power was added to man's energy, thereby doubling the magnitude to 4000 kilogram calories per capita per day. This second period extended for approximately 7000 years until the invention of the steam engine in 1775. Since that time the machine age, developed with the utilisation of coal, electricity and oil, has stepped up capacity in such a country as the United States to 160,000 kilogram calories per capita per day.

It is the lag of 18th century economic and political institutions behind this 20th century power that has become the basic world problem. Reconstruction to overtake this lag in the application of scientific knowledge to human welfare is confronted by two problems: the material one of the lag itself and the larger social one of instituting the necessary collectivism while safeguarding the maximum degree of individual freedom commensurate with the welfare of the group as a whole.

Social reconstruction to be successful requires technical knowledge and the most efficient form of organisation for the application of that knowledge. It is axiomatic that the form of administration is determined by political organisation and that in turn derives from the per capita energy production of the country and the economic philosophy. The organisation in democracies has been determined by capitalism. Capitalism as a system was first defined after the beginning of the Industrial Revolution and then passed through the three periods of Industrial, Monopoly and Finance Capitalism, corresponding roughly to stages in the progress of Science particularly with reference to its development of power and transportation, because these two are the new major factors.

Industrial capitalism resulted in the form of social administration designated as democracy but has never attained to the substance. The latter is defined as "the form of government which asserts the worth and validity of the individual man and that the aim of society is to secure to him the maximum of responsible freedom". This definition means that society itself must consciously and responsibly aim at social justice which will ensure the closest possible approximation to equality of opportunity for each member to lead the 'good life'. Consideration of rural reconstruction in the restricted sense of this paper implies the enumeration of the unsocial biological results that have arisen in older industrialised countries and which planning should aim to avoid in countries now becoming industrialised. Such an enumeration includes the problem of population, human migration, race, health, urbanisation, rural economic crises, cultural lag, social pathology, including diversification of social classes and groups, and poverty. No successful scheme of rural reconstruction can be formulated without knowledge of, and conscious consideration to obviate, these problems that inevitably follow in the wake of uncontrolled industrialisation, economic development and unplanned democratisation. It is not, however, within the scope of this paper to go beyond the hope that officials submitting plans of reconstruction designed to overtake social-economic lag in rural communities possess the knowledge of, and have given the necessary consideration to, the foregoing pre-requisites of historical perspective. Major economic factors arising from scientific progress and their resultant problems when uncontrolled must constitute the background of any thinking, if reconstruction is to claim planned technical competency and is to prove successful.

In addition, the administrator must have the equally necessary knowledge of and consideration for the social fields in which application has to be made. Society in the course of evolution has gradually differentiated, or is in process of differentiating, certain major functions listed below:

- (1) Education.
- (2) Protection of Life, Property and Natural Resources.
- (3) Production of Goods and Services. . Distribution of the Returns of Production.
- (4) Consumption of Goods and Services.

- (5) Communication and Transportation.
- (6) Recreational Use of Leisure.
- (7) Expression of Religious Impulses.
- (8) Expression of Aesthetic Impulses.
- (9) Integration of the Individual (Service to Society).
- (10) Extension of Freedom (Political Education).
- (11) Extension of Knowledge and Adaptation to Invention.

The first seven have been clearly differentiated while the last four are sufficiently recognisable to be thus classified. Certain of these major functions in turn have become so well established that they now have developed sub-divisions which are themselves autonomous social administration, as, for instance, Public Health under Protection, and Industry or Agriculture under Production, etc. Consequently, individuals responsible for planning reconstruction in the sense of overtaking the lag in utilisation of knowledge should presumably possess technical information of the extent the organisation and administration of each has developed in progressive countries, particularly with respect to their latest trends in order that their experience is available to obviate introduction of wrong methods of organisation and administration in the backward community under consideration. Furthermore, the complexity and vastness of modern social-economic organisation implies that the social architects in charge of reconstruction must possess comparable knowledge of *principles* requisite for successful organisation and administration of each technical field for which establishment is being undertaken; and, without which the structure planned for is as much doomed to collapse as would be the building of a skyscraper or ocean liner by architects proceeding merely along the lines of neolithic rural-cum-empirical knowledge. An example may be taken from the field of public health.

Public health is organised community effort to provide individuals of the community with the greatest degree of utilisation of medical knowledge for the three objectives of maintenance of health, the prevention of diseases, and the cure of disease. The organisation to attain these objectives effectively together constitute public health administration. Experience has postulated that efficient administration

is proportionate to adherence of the following six principles:—

- (i) The necessity for the administration of the different health functions being undertaken for the whole community by a single governing body and not for different sections of the community by several governing agencies, with necessary co-ordination between inter-related sections; in other words, there should be 'centralized direction and decentralized activity'. The administration must provide for technical supervision and periodic appraisal of the efficiency of the organisation.
- (ii) Successful administrative procedure results only from scientific investigation and demonstration of organisational methodology in the measures whereby knowledge can be applied in practice to groups of population. The proper training of the necessary personnel in applying the methodology is an important requirement.
- (iii) Successful administrative procedure must be based upon sound financial considerations and practicable economic budgeting suited to the area and the population. Where cash purchase of health reform is difficult, the available cash may be utilized for technical guidance and supervision and the citizens may offer trained voluntary labour (=payment in kind), which is the largest item in cash purchase of medical protection.
- (iv) Successful community utilization of knowledge for public health reform and medical protection requires a certain level of politico-economic progress and education. Health of the people is eventually achieved through the people being themselves possessed of adequate education in, and practice of, health knowledge.
- (v) The securing of co-ordination between the related spheres of social services, owing to their mutual interdependence.
- (vi) In order to ensure between working and to avoid mistakes in local effort, the whole design of a public health planning must be before the mind from the beginning. Any

effort, however small and localized, can confer benefit, if it is designed in relation to the scheme as a whole.

These principles may aptly be termed the normal functions of that organ of society designated public health, and disfunctioning of any one or more must produce social pathology resulting in the symptomatology of increased morbidity and excess mortality. The second is the one most observably violated in Bengal, where, for instance, the specific mortality for the past decade from such an entirely controllable a disease as small-pox has been 43 per 100,000 as compared with 0.07 and 0.02 for the Philippines and Java, which formerly had the same high rate as Bengal. Consequently, it behoves that reconstruction relating to medical protection to be successful must be planned in terms of these principles rather than be undertaken empirically and so be doomed to inadequate and disappointing results. Similar competency to plan in terms of principles for each social field must be the qualification of any Director of reconstruction, who is in this respect comparable to the Chief of General Staff who would not presume for an instant to undertake, himself, the planning or the operation in any single field but solely discharges the function of co-ordinating into a whole scheme the technical principles and resultant details from the several differentiated technical fields.

It has been stated, apart from the immediate problem of overtaking the social lag in as backward a community as China, *i.e.*, catching up on the present, that immediate planning had to be undertaken in terms of larger world trends, *i.e.*, in terms of the future, to obviate the necessity later on for reconstructing the organisation then being established. The principles governing and determining the whole eventual social design were not new. For instance, one of the major social results of technological developments since the middle of the nineteenth century was the bringing into prominence of classes who formerly were largely voiceless. "Democratisation of society" ran parallel with the ever-growing interdependence of individual activities upon one another to constitute a large whole of efficient social function. Technological advances transformed individualistic into a herd society, in which individual competition was replaced by group co-operation. The resultant subordination of the individual was compensated by the improved economic and cultural levels necessarily obtainable only through group action and therefore planning.

The impact of science and industrialisation upon *laissez-faire* agricultural civilisations increasingly created individual insecurities thereby resulting in herd impulses towards salvation by organised security. This produced expediency palliatives through various forms of social welfare and new deals inaugurated especially during the past half a century. One of the results is the transition from recording history in terms of the past to the development of a sociology attempting to shape history out of the emergent forces of the social process now going on and so avoiding the necessity for future palliatives. This recent trend is important as marking the first period when man is collectively setting up goals and organising himself and society towards scientific attainment of these goals through planning and planned thinking.

Planning requires grasping the complex of events from a number of key positions, from each of which the whole design has to be kept in mind in undertaking individual steps. It is only through this approach that concrete social events previously thought to be accidental can be seen to be the result of principles working throughout the society and that their occurrence can be predicted. Mannheim designates these forces as "the principia media"; and the importance of understanding these forces for social reconstruction arises from the fact that society cannot be rationalised as a factory, because its complex and various living characteristics if not understood will upset the plan. Consequently, planning is the application of foresight to human affairs, so that social progress increasingly proceeds towards a unity regulated through differentiated knowledge of the major social functions. The problem involved is twofold, because in addition to reorganisation of society, there must be the freeing and full development of individual man through a new education. The chain of events constitutes a cycle beginning with Galileo and Copernicus and extending through Arkwright and Watts to the changing ideas about man from Rousseau and Herbert Spencer to the contemporary encyclopaedists. The lag of social techniques must overtake mechanical inventions and technological improvements. This demands the achievement of a dynamic equilibrium that must solve the problem of security of the group as a whole. This can be accomplished only through adequate social techniques co-ordinated towards a general defined objective. Such planning would produce a rational mastery of the irrational forces of

uncontrolled industrialisation. The fundamental basis must be education whereby human beings become influenced towards desiring the greatest good of the society as a whole. Numerous educational experiments are being made, specially in the past two decades, directed towards this aim. In turn social techniques require a new type of personnel for administration which is resulting in the civil servant developing into the social servant. In brief, science and increasing industrialisation imposes the necessity for functional rationalisation of social organisation towards objective ends. A planned economy implies definite social goals to avoid being a contradiction in terms. This requires a planned social strategy to co-ordinate all fields of human endeavour through organising social action towards the optimum good of the greatest number. The foregoing has been re-postulated and summarised by Mannheim in '*Man and Society*' from which much of the summary view-points has been borrowed. This review of the sociological thought of the constituent members of the Council may seem unduly lengthy. It however must be fully comprehended to understand the underlying philosophy and aims of the Council and of the goal of rural reconstruction. The description in 1910 of a model T Ford in itself might have proved an interesting new phenomenon in transportation but without comprehension of the underlying principle of the internal combustion engine the description could not foretell either the 1940 Mercury or the Spitfire, which a knowledge of the principles of the crude 1910 engine would permit envisaging.

'*Land Utilisation in China*' edited by J. Lossing Buck, (1937) is a basic study of agricultural and population problems from which further social-economic details are obtained but a summary picture of rural China is as follows. The land under cultivation is 27 per cent. Agricultural development is difficult in consequence of fragmentary holdings. Landowners consist of 44 per cent of the agricultural population; 23 per cent are part-owners; and 33 per cent tenants. The medium size of farm area is 3.3 acres. Taxation varies widely from locality to locality but may be said to be 5.2 Chinese dollars per acre. Illiteracy exists amongst 69 per cent of males and 99 per cent of females. The death rate per 1000 of population is 27 and the birth rate 38.3. 39 per cent of farmers are in debt. The per capita income for rural areas is 80 Chinese dollars per annum, including the value of all the product supplied by the farm.

WAR

While the China Incident of 1937 disrupted the Council's work almost at its inception in terms of materialisation of the eventual plan conceived along the broad principles enumerated above, it may be of interest to report the immediate specific programme in mind when war was declared. The Council had accepted the three necessary factors in social planning, *viz.*, population, natural resources, and the technical arts, with the objective of correlation of these three factors in terms of the principles referred to. These in turn resulted in the postulation of the three initial problems that must be successfully solved in social application, namely, competent personnel, successful methodology and the problem of organisation including finance. The first two were considered the production aspect of rural social planning while the third was the marketing of what has been produced for the benefit of the community. Thus, the universities constituted the factories of methods and personnel and the Institute field the testing laboratory for marketing. The Council considered that the determining one of the three above factors of social planning was that of power, and that consequently an area whose size and boundaries had been decided entirely by a pre-machine age conditions would not permit the solution of the eventual problem in mind. This problem is internationally similar in nature and has probably been best defined with respect to the Tennessee Valley Authority and described below. When the China Incident arose, the Council was actually in process of proceeding along the following lines to implement its responsibilities of social planning along neo-technical lines.

The Council through the National Economic Council was considering a survey of the natural self-contained power units of the country similar in scope to that undertaken by Roosevelt for the United States and whose report has predicted the eventual redistribution of political boundaries of that country's 48 States in terms of seven natural power provinces. It was expected that the completion of such a survey in China would then permit the North China Council to remove its Institute to one of the eventual units for its development on a planned social-economic basis. There seemed every likelihood that there would be no difficulty in securing the large capital which would have been required to develop the power of that area and that must constitute the starting point of a really planned and largely

self-contained community. The war naturally suspended development along these lines.

Any conclusion of possible international value from the efforts towards rural reconstruction in China described above would seem to be the extension of university interests to community problems and recognition of responsibility for its colleges in the social fields to undertake research in determining methods for the efficient utilisation of knowledge for the betterment of human welfare and training in these methods. In this connection it is of interest to note the trend of thought in the United States in connection with the experience of the Tennessee Valley Authority already referred to. This experiment is probably the single greatest effort outside of the totalitarian States to develop co-ordination between control of national resources and their more efficient utilisation for human welfare through the social organisation of society; embracing as it does an area covering part or all of seven States with a population of 10 million. The present Director of the Authority, Dr Morgan, has postulated (1938) that, "Unless the appropriate fields of universities can be brought into a more realistic relationship with the problems of our democracy, there will be no basis for assurance as to the future. For if this is not done, there is little reason to believe that the basic conflict of ideals in our capitalistic democracy can be resolved sufficiently to preserve public confidence in democratic institutions as a way of life".

Dr Morgan's reason for his conclusions was derived from the experience of the Authority which resolved the multiplicity of local reconstruction problems under four heads:

1. Land
2. Economic
3. Social
4. Political or Governmental.

Thus, under 'Land' are included conservation and utilisation of natural resources, the problems of flood control, soil poverty, farm tenancy as well as the conflict between agriculture as a way of living and agriculture as a commercial or industrial undertaking, in addition to the problem of agricultural surpluses. 'Economic' includes the effects of local, national, and international markets on problems of plant food supply, the imbalance of population with the centralisation of industry etc. The 'Social' problem includes housing, collective bargaining, technology and

unemployment, farm tenancy, etc. The 'Political' problems raise the questions as to whether governmental units should be based upon political or economic considerations; how to make legislation responsive to public needs; the whole subject of taxation, etc. Analysis of any single major problem revealed its inter-relationship to others of equal magnitude. Analysis of the etiology and the previous effort at solution of these problems indicated their hitherto unrelated channels and consequent failure of solution, thereby perpetuating the fallacious public notion that our evils are unrelated to their causes.

The approach to solve these problems revealed three great needs that had to be met and which revealed that the single greatest problem should be Education, *viz.*, the University, because these three needs proved to be personnel trained in reconstruction, a better informed public understanding of what a successful programme involved, and technical and scientific research capable of being related and translated into solutions of regional and national problems. This extended social responsibility of scope of universities implied not only research into the problems listed but a *translation programme* whereby a system of education should be developed in order that courses of study should include exercises, laboratory and field demonstrations, in the social-economic problems of today, adequate to accommodate instruction from Kindergarten to Graduate and Adult Education. The problems in the more economically-backward China led to the same general conclusions.

It may be of interest to conclude by summarising some of the interesting war developments of the Council groups following the necessary flight of its Institute from Shantung to Kweichow and later to Szechuen.

CONSEQUENT CHANGES

There is not time to give credit due to the indomitable spirit of the faculties and students of the numerous institutions which had to flee into Free China, often overland marches of over a thousand miles on foot. The chief effect on the Council was that the geographical separation of universities from the Institute precluded the latter from continuing its university functions. The Institute staff remained largely intact and it was

reconstituted in 1938 in the Tingfan sub-division of Kweichow province as a vocational training institute to serve provincial reconstruction needs. In the meantime, the Mass Education Association had removed its headquarters from Hopei to Hunan province, where it was given the responsibility by the National Government of organising a provincial public-administration training institute of a vocational nature for a complete war-reorganisation of the administration of the province, which was expected to be the front-line after the fall of Hankow. Developments forced the evacuation of the Movement to Szechuen province. Here, in early 1940 the Movement under Mr Yen in collaboration with the Council Institute established a National College for Rural Reconstruction. This is in effect an institute for training of three categories of personnel in public administration, which was made possible by the removal of the Institute's resources from Kweichow to Szechuen. The newly-constituted college was provided with Tachu, the tenth prefectural area of the province, as its community field and immediately inaugurated post-entry training of two types: an A type for senior administrators consisting of mature men, many of whom had received their training abroad and had held administrative posts in China. The second, B type, was for young graduates to constitute junior personnel. In addition, it is expected that opportunity would afford in 1941 for re-affiliation with universities who had located themselves in the province, in order to renew under-graduate training. The reconstituted institute, in its training-research programme, retains the six departments which were established in Shantung. Its non-routine-administration budget however has had to be reduced to approximately Rs. 2½ lakhs per annum.

One of the most significant war reconstruction development of the Government has been Industrial Co-operation. China's modern industry had become established only near the treaty ports and this was the area occupied by the Japanese within the first 12 months of the China incident. Free China could only remain free provided in addition to war supplies she could assure a minimum of essential consumer goods. Circumstances of transport and of particularly finance would have made import almost prohibitive. Fortunately the imagination and foresight of a half a dozen private individuals were able to bring together the two essentials required for the establishment of industrial co-operation, namely, tools and trained

workers. A significant quality of the former were evacuated to the interior from the coast by Herculean effort. There were hundreds of mechanics of various categories among thousands of refugees and these were registered and assigned to specific functions. Initially the movement got under way through private funds collected by the small handful of enthusiasts whose demonstration was sufficient to 'prime the pump' in obtaining Government support. In less than three years, some 1700 societies with 23,000 members have become established with a monthly production of 8 million Chinese dollars. The dependents of these members number 200,000. The products come under ten main categories and are meeting an important part of the nation's military and industrial needs. It is expected that the eventual establishment of 30,000 of these co-operatives will provide an economic base which would make China relatively independent of most of the essential items hitherto imported.

Many of these industrial co-operatives have formed also supply and marketing departments. The movement has been fortunate to enlist foreign expert advice on technical matters and some degree of research. These emergency societies will undoubtedly lead to a future national federation after the war. Groups of them have already formed Unions, the various departments of which are linking up with Farmers' Societies for the purchase of raw materials, and it is hoped that this will result in the permanent establishment of numerous consumers' Societies, and bring about the completion of the co-operative circle, with the pre-war credit and marketing societies. Another ancillary activity, although possibly as significant as the establishment of industrial co-operation itself is its development of education. The Chinese co-operative law decrees that 5 per cent of the profits must be utilised for a common good fund. The industrial co-operatives are providing 10 per cent for schemes of education and welfare. This education is remarkable in that it emphasises manual skill and science as well as literary and social activities in the group. There has been an additional problem to solve in meeting the necessity, particularly under the war time conditions, to train staff for the rapidly expanding industrial co-operation movement and which has been initiated under almost insuperable difficulties in 7 regional institutes, where organised courses for 10-12 weeks are given as preliminary to 'post entry' training in the co-operatives themselves.

DIFFERENCES BETWEEN CHINA AND INDIA

Rural reconstruction to overcome the lag between Mediavalism and the utilisation of modern knowledge cannot be successful if dependant entirely upon cash purchase. The latter on account of low economic conditions and inadequate purchasing power must be limited largely to providing the training of self-help workers and their supervision together with necessary additional technical functions which cannot be provided through voluntary effort. The recognition of this principle came early in the Chinese experience as it has here also in India. But in China there are two fundamental differences that supervision through cash purchase is functional and specific rather than general and non-specific as in India and that training of voluntary workers is chiefly through drills while lectures are limited entirely to demonstration as the reconstruction worker can be trained successfully only by action and never through talk. The former difference requires amplification. The specific problem of reconstruction is postulated as follows:—Knowledge of better seeds, of improved animal husbandry, of successful methods of co-operation, of control of causes of excess mortality due to gastro-intestinal disease, malaria, smallpox, etc., is available but the problem is development of methods which will bring the knowledge within the practice of the individual villager. It would seem that the trend in India, referring to Bengal particularly, is to select trainees from groups of villagers in each *thana* who will each be provided with a smattering of knowledge in all fields during the period of a few weeks in camp and upon return to their respective villages will be responsible for initiating new practices in these fields into the daily lives of the villagers. Supervision of these peripheral and voluntary workers comes through the Circle Officer, who possibly may content each trainee once a month or at longer intervals. This Circle Officer himself is a general administrator, who has not had technical training in any specific field. Consequently, while possessing an intelligent realisation of the problems involved he must refer technical matters for solution to the duly constituted authority somewhere between him and the Divisional Centre with all the delays attendant in India upon instituting a new file and securing action. However, the most serious defect is the absence of proved methodology in which the trainee can be drilled. This methodology for the purpose in view must be one that under technical supervision has been shown to be practicable of

undertaking by voluntary 'self-help' effort. It is insufficient, for instance, to tell the trainee that gastro-intestinal disease is due to soil-pollution and contaminated water to be controlled by sanitary night-soil disposal and safe water. He must, himself, be given repetitive opportunity to dig latrines and wells. And these and other drill measures must have been previously standardised for local conditions.

The Chinese methodology was developed along functional lines as being more effective under rural circumstances. Experience proved that a voluntary village worker with the limitations of his own education and the technical background providable in a brief period could not effectively undertake self-help development in more than one field; and, he could even then do this only if provided with constant technical supervision. The result of experience led to the following unit schemes of organisation based upon an area and population that in India would be a sub-division. Administering this is encountered the first 'general' administrator, under whom were functional divisions designed to bring the necessary technical supervision to the voluntary village worker at frequent intervals. In turn, the village workers were designated by each one or two villages (approximately 200-300 families) for training in each major field provided at the subdivisioinal centre and as stated the training was entirely drill. Supervision and technical services were organised in terms of the particular administrative needs of each field. For instance, the maximum number that could be handled by the unit of the primary health centre was found to be 20,000 population in a radius of 3-5 miles, whereas the primary peripheral units of agriculture and of co-operation were 4-5 times this area and population. There is no time to describe the detailed administration of even one field. But the following summary of the public health may illustrate the principle in question. Self-help in the village was represented by three individuals:—the voluntary health worker, the school teacher, and the 'dai'. Each received a period of drill at the secondary subdivisioinal centre in previously defined standardized routines. The technical staff at each primary health centre consisted of what in India would be designated a sub-assistant surgeon, a visitor and a dresser-compounder. These had received drill training at a district base. The primary-centre personnel discharged their curative functions in the mornings to the patients largely referred from the village health

workers and in the afternoons rotated through the 15 or 20 villages to undertake supervisory technical functions chiefly preventive. The primary centre staff returned to the Sub-Divisional secondary centre over the week-ends for 'post-entry' training. In the meantime the 'D. P. H.' type of personnel at the secondary subdivisioinal centre spent part of the week supervising the primary centres. Similarly, the village workers, as circumstances demanded, attended the primary centres for conferences, and once a year returned to the secondary centre generally during New Year's. The cost of such a health administration was approximately 15 Chinese cents per annum or from 2 to 3 annas per capita, taking the purchasing power of the rupee as equivalent to the Chinese dollar.

The mechanism of rural reconstruction as eventually stabilised was to take the sub-division (hsien) as the unit of operation and to set-up the secondary centre at the subdivisioinal headquarters. This included technical personnel and facilities for each of the social fields. Mass education was the vehicle through which other reconstruction activities were built around. Experience proved that little value could result from education of adults after the age of 30 years and consequently mass education was limited to adolescents and young adults. The products of education were constituted into a self-governing village association who selected individual members to be sent to the secondary centres for training in the separate fields and then upon completion of training were made responsible for the extension of activities in that field within the village. As has already been indicated in each field the voluntary workers were provided with standardized plans which were supervised from the primary technical centre of each administration. It was considered that the initial stage of reconstruction was passed when the village in question had reached the level of constituting its own primary school, the teachers for which, regardless of previous conventional training, were given additional instruction at the Normal School at the secondary centre. Stabilisation of reconstruction required the period necessary until the products of these schools could take their place in the community. The pedagogic motive within the school was one whereby the pupils reduplicated various activities of community life in their school syllabus particularly in agriculture, co-operation, health and civics.

The characteristics consequently of Chinese reconstruction are :—

- (a) Specifically trained voluntary self-help in the villages for each major social function to be reconstructed.
- (b) Weekly supervision of voluntary workers in each field by specialised technical officers.
- (c) Administration organised by specialised function from the secondary sub-divisional centre through to primary centres in the villages. The first generalised officer met with was the one administering a sub-division.
- (d) The development of administrative methodology is the responsibility of universities who themselves control large units of population for the purpose of determining practical means of applying basic knowledge for the welfare of the individuals in the community. The university is naturally also responsible for training the senior administrative officers in each major field of application

of knowledge. The junior personnel are trained locally at the district base while the village workers receive their training at the sub-divisional secondary centre.

The equipment and methodology of activities from the sub-divisional base to the village were standardized.

The primary function of reconstruction in China was to initiate and to co-ordinate interested and duly constituted organisations and institutions to the joint solution of social-economic problems of the villages. Reconstruction administration did not include the responsibility either of solving the technical problems, which were considered to be a responsibility of institutions, or of administering activities that was the responsibility of duly constituted technical administrations. This policy seems significantly different on both counts from that developing in India, where reconstruction *qua* reconstruction not only itself attempts to develop the methodology to solve the social-economic problems but is even undertaking administration duplicating duly constituted administration. This policy is wholly untenable and will have to be revised if reconstruction in India is to produce significant results.

ELECTRON MICROSCOPE DISCLOSES SOAP'S TWISTED FIBRES

By aid an electron microscope, magnifying reality 113,000 times, scientists have seen the mysterious structure of soap. Soap is revealed as consisting of bundles of fibres, some of them twisted, reports Dr J. W. McBain, Stanford University professor of Chemistry. Possibility that soap may be photographed in even greater minuteness, showing the very atoms that make up the molecules, is foreseen, as the next step towards solving soap secrets. Scientists admit that they still do not know what happens chemically when you wash your hands with soap. Dr McBain believes that when the physical structure of soap is understood, it will be easier to discover why soap dissolves dirt.

Notes and News

OBITUARY

Sir Shah Mohammad Sulaiman

By the sudden and untimely death of Sir Shah Mohammed Sulaiman, India has not only lost a great jurist and a great scholar, but scholars all over India will miss in him a genuine and sympathetic friend. He died prematurely at the early age of 56 in full possession of mental and physical vigour. Great things were expected of him but he has passed away with his mission unfulfilled.

Sir Shah Sulaiman came of an old family of Muslem scholars who had been settled for over 500 years in Jaunpur. We always read in history of Muslem invaders but we hardly realise the large number of learned scholars who were brought in their train to India to build up centres of Arabic and Persian culture. Sir Shah Sulaiman's family was one of these types and had produced a long line of Persian and Arabian scholars. The most prominent amongst his ancestors was Mollah Mahmud who in the time of Emperor Shahjahan had acquired a great celebrity as the foremost exponent of the Muslim scholarship in the sciences of astronomy, physics and chemistry. He was sent by Emperor Shahjahan to Central Asia to study the organisation of the Great Observatory at Somarkand built by Ulugh Beg, grandson of the famous Tamerlane, but unlike him a mild ruler and accomplished scholar. This Observatory, it may be mentioned, was the best of its kind in the world in the 15th century. Mollah Mahmud submitted full plans for the construction and maintenance of an Observatory in India, but this was not given effect to, because the funds reserved for this purpose had to be diverted to other purposes. The Observatory came nearly 100 years later through the initiative of Maharaja Sawai Jaisingh of Jaipur, who was commissioned by the Emperor Muhammad Shah to carry out this task.

Dr Sulaiman's father was a pleader at Jaunpur and he early distinguished himself in his studies, particularly in the mathematical and physical sciences.

Late Professor Ganesh Prosad was one of his teachers and from him he imbibed his taste for mathematics. He stood first in B.Sc. examination from Allahabad University and received a State scholarship for studying abroad. At Cambridge, he took his degree in mathematical tripos and missed his wranglership, being placed in the second division (senior optimes). He returned to India as a barrister about 1909 and set up private practice in the Allahabad High Court. Within a short time, he built up a very extensive practice and became one of the foremost members of the Bar. He was elevated to the Bench in 1920 at the early age of 34, and while still in early forties, he became chief justice of the Allahabad High Court in 1932. His work as justice and chief justice was marked by vast erudition and quickness of decision. In spite of absorption in his legal and judicial duties, he always retained his interest in science. As soon as he could get some relief from his onerous duties as chief justice, he returned to his old love with grim determination. He was very fond of the company of scholars and for every physicist and mathematician at Allahabad, his doors were always open. He tackled one of the most abstruse subjects of the present times, namely the theory of relativity. He was able to deduce some of the results of Einstein with simpler mathematics and in spite of what has been said nobody has yet been able to find any flaw in his mathematical calculations. He felt however that the proper domain of the application of the principle of relativity was modern physics, a subject of which he had not much knowledge, and he turned his attention to the study of physical sciences. But this work has been left unfinished by his untimely death.

The writer of the present note feels his loss more than a personal one because in course of his long stay at Allahabad, he had developed intimate friendship with Sir Shah Sulaiman. Besides taking interest in mathematics, he took interest in other cultural subjects. Following the traditions of his family, he had collected a large number of old Arabic and Persian manuscripts and had arranged to publish them with the aid of learned scholars. As a vice-chancellor of Aligarh University, he brought new life to the institution. He knew almost every member of

the Muslim University personally, and nothing gave him more genuine pleasure than watching a young man work hard and get laurels at home and abroad.

A more detailed life sketch of Sir Shah Mahammad Sulaiman will be published in a subsequent issue, after we are able to collect more details about his career.

Sir George Abraham Grierson

THE death has occurred of Sir George Abraham Grierson, the famous authority on Indian languages. Born in Dublin in 1851, he was appointed to the Indian Civil Service in 1873 and spent most of the period of his official career in Bengal and Bihar. Sir George had studied Sanskrit and Hindusthani even when he was an undergraduate at Dublin University and his long stay in India gave him the much-desired opportunity to continue his studies in Indian linguistics. For five years before his retirement from service in 1903, he was put in charge of the Linguistic Survey of India and the results of his labour are embodied in his monumental volumes on Indian languages. Even after his retirement from India he wrote many papers in various journals of oriental societies and made contributions to the *Encyclopaedia Britannica* on Indian languages. He was the recipient of a number of honorary doctorates from several universities of Europe and also of a number of prizes of international societies like the French Academy, the Royal Asiatic Society, etc. He was also a fellow of many learned societies and international linguistic institutions. He was created a C.I.E. in 1894, a K.C.I.E. in 1912 and was awarded the Order of Merit in 1928.

Honorary Doctorate for Sir Nilratan Sircar

At the last convocation of Calcutta University the degree of doctorate of science (*honoris causa*) was conferred on Sir Nilratan Sircar, M.A., M.D., L.L.D., D.C.L. In this connection the Vice-Chancellor, Sir M. Azizul Haque, recalled the long association of Sir Nilratan with Calcutta University and his worthy services for the cause of education in the province. For nearly fifty years he has served the University in various capacities, as a fellow, member of the syndicate, dean of the faculty of science and medicine, president of the council of post-graduate teaching in arts and science, and also as vice-chancellor. For nearly half a century Sir Nilratan has occupied a unique position not only among the members of his profession but in the public life of the province as a pioneer in all movements relating to social reform and educational advancement of the people. The Univer-

sity has done the proper thing in honouring one who so rightly and richly deserves it.

University's Role During World Crisis

"The universities of the world have always been in the forefront of carrying on a vast amount of scientific researches for the varying purposes of national development and national defence", said Sir M. Azizul Haque in his address delivered at the last convocation of Calcutta University. In the midst of terrible international conflict as we are today, all countries have more or less to fall back upon its own resources, the development of which is a primary need and is not less important than military defence. Intensive researches in applied science are necessary for exploring and utilising these resources but Sir Azizul put the pertinent question, how far have we done that in this country? Are we in a position to manufacture in India all the steel and iron locomotives and machineries, electric goods, telephone and radio parts, that we require for our present needs? To what extent can we produce the medicinal and other basic requirements of the country? How far has the power of nature available in the country been utilised for its economic development? A much belated start has been made in this or that respect and some amount of useful work is being done at present but the Vice-Chancellor rightly pleads for a large share of the work to be entrusted to the universities in the country. The Indian universities are willing to play their part and take up the vast amount of research necessary for the utilisation of the country's resources for national defence and self-sufficiency. But this can only be done provided the universities are endowed with sufficient funds.

The Right Hon'ble Sir Tej Bahadur Sapru who was specially invited to address the graduates at the convocation also harped on the same tune when he urged the professors and scholars of the university to do their share in enriching the industrial and economic life of the country by the result of their researches. As for the necessary funds Sir Tej Bahadur said, "In my opinion it should be the primary duty of every Provincial Government and indeed of the Central Government to help them in a generous measure with grants for the purpose of such useful pursuits". The universities in India have never had reasonable financial aid from the State for the prosecution of scientific research and the work that has been done hitherto has been made possible mostly through private benefactions. Now that the Government have realised the necessity of financing on a much larger scale various research programmes for the utilisation of the country's natural resources, it may

be reasonably hoped that considerable financial aid will be given to the universities so that they may play their parts in all such research activities.

Bengali Journal of Science

We are glad to welcome the appearance of a new Bengali journal of science, *Vijnan Parichay*, the first issue of which was published in January, 1941. The journal, which will be published bi-monthly, aims at disseminating and popularizing the knowledge of sciences through the medium of the vernacular language. In recent years Calcutta University has made Bengali the medium of instruction in the secondary schools and has also introduced elementary science in the curriculum of the matriculation examination. A Bengali journal giving up-to-date information regarding the progress of science in various branches in a simple and popular style will certainly be of great benefit to our younger students and the wider public. The appearance of a journal of this kind has been quite opportune and we hope the journal will receive the appreciation and encouragement that it deserves from the educated public of the province.

Total Solar Eclipses of 1940 and 1941

ASTRONOMICAL observations made during the last solar eclipse on October 1, 1940 are expected to give results of importance which will prove of value in the theoretical study of the sun's chromosphere and corona. The weather conditions throughout the belt of totality in South Africa at the time of the eclipse were favourable and the eclipse was described as a perfect one in every way for astronomical observations. Extensive preparations had been made for observations to be made by parties from Great Britain, Holland, United States etc., but unfortunately the plans were almost completely upset by the war and a favourable opportunity has in a large measure been lost.

The eclipse attracted much popular attention in South Africa. Even the Prime Minister, General Smuts, who is a member of the Astronomical Society of South Africa spared time to fly from Pretoria to Cradock to view the eclipse. A party from the Cape Observatory under the direction of Dr Jackson made observations of the Einstein deflection. The results are not yet available.

Spectroscopic observations were made by Dr R. O. Redman of the Radcliffe Observatory, Pretoria, at Calvinia with a moving plate camera sent out to South Africa by the Solar Physics Observatory,

Cambridge. The purpose of the observations was to photograph the transition from the Fraunhofer to the chromospheric spectrum. Dr Redman is pleased with the observations obtained and expects some valuable results when the photometry of the spectra has been completed. Dr C. W. Allen of the Commonwealth Solar Observatory, Canberra, photographed the flash and coronal spectra with a high light collecting-power spectrograph. To determine the degree of polarization in the corona with a view to throw light on the question of nature of the reflecting particles there, Dr Allen used a polarigraph, with which the corona was photographed through red and blue filters. All these astronomical observations were made possible by grants from the Government Grant Fund administered by the Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society.

Astronomers are now looking forward to their next chance which will come on September 21, 1941. The best places to see the next total solar eclipse will be on the Coast of China, between Foochow and Wenchow, as well as Hankow and Nanchang. No definite plans have yet been made as it is questionable whether foreign astronomers will be able to set up their instruments in those areas in next September. The tip of the moon's shadow on that day will first touch the earth at sunrise in Russia near Astrakhan. Then it will cross the Caspian Sea, the Aral Sea, Turkestan, Tibet and China. After that it will cross the Pacific Ocean including the American island of Guam. The sun will be blacked out for a maximum period of nearly three and a half minutes in China.

Medal Awards of the Royal Society

The Copley medal has been awarded to Prof. Paul Langevin whose most well-known work is the foundation of the electron theory of para- and diamagnetism. He has had a great international influence and after the death of Lorentz, was elected president of the *Institute International de Physique Solvay*. He was awarded the Hughes medal in 1915 and elected a foreign member of the Royal Society in 1928.

The Rumford medal has been awarded to Prof. Karl Manne George Siegbahn for his high precision X-ray measurements. Siegbahn is at the same time a great engineer and has made inventions and improvements in every useful type of apparatus connected with X-ray measurements. He has written a masterly book on the spectroscopy of X-rays. He was awarded the Hughes medal in 1934.

A Royal medal has been awarded to Prof. P. M. S. Blackett distinguished for his work on

cosmic rays. Simultaneously with Anderson in America he discovered the tracks of positrons in cloud chambers. He has also made important contributions to our knowledge of the heavy electron.

A Royal medal has been awarded to Dr F. H. A. Marshall, noted for his researches on oestrous cycles, corpus luteum and removal and grafting of ovaries. He is the author of the well-known text book on the '*Physiology of Reproduction*' and is generally acknowledged to be the father of this subject.

The Davy medal has been awarded to Prof. Harold Clayton Urey who first succeeded in isolating deuterium. For his work on the isolation of deuterium and establishing the thermodynamic, spectral and physico-chemical difference between the same and pure hydrogen, Urey was awarded the Nobel prize.

The Darwin medal was awarded to Prof. James Peter Hill well known for his researches on the development of various mammals. Few living biologists have contributed more towards the solution of problems bearing on the inter-relationships of the main groups of the mammalia and on the phylogenetic history of the Primates.

The Sylvester medal has been awarded to Prof. G. H. Hardy who has done much to build up the technique of modern mathematical analysis. His most outstanding contributions have been in the theory of Riemann Zeta-function and the theory of numbers.

The Hughes medal has been awarded to Prof. A. H. Compton whose work on the scattering of X-radiation is of fundamental importance in the general theory of the interaction of radiation with matter. Of late years Compton has been one of the leaders in the study of cosmic rays.

Sir William Bragg's Address at Royal Society

IN his presidential address to the Royal Society Sir William Bragg gave an impression of the increasing part which science is taking in promoting national welfare in Great Britain. Last year a very important move was made in the formation of a scientific advisory Committee under the chairmanship of Lord Hankey with a reference which in effect directed it to consider the advances of science in their relation to national welfare. A committee consisting of authorities on nutrition, agriculture and economy was also set up last year to consider the scientific aspects of the food policy of the Government. "These committees have close and direct association with the Cabinet. Hitherto men of science were taken in various Government departments to act as useful

items in departmental machinery. But the new committees not being part of any executive body are not hampered by traditions or by set habits. The Scientific Advisory Committee is meant to watch all occasions and opportunities for the employment of science in the service of the nation and also for the continuous encouragement of that employment.

On behalf of men of science the president rightly stated: "We do claim that authority shall be exercised in the light of a knowledge which grows continuously and with continual effect on politics, on industry and on thought itself We shall be taking the better way if in all ranks of the state, and especially in those that have authority and set an example, we can arouse a general appreciation of the position of, and a constant understanding watchfulness on the increase of knowledge and the uses that are made and can be made of it".

It is not universally or even sufficiently understood how important the knowledge of science has become in every kind of enterprise. Since science has assumed such a great influence on all human affairs, it would be quite perilous to leave its uses to persons who cannot or do not use it rightly. If scientists, in their continually increasing contacts with public affairs, can show that they have something of great value to contribute and that they give it freely forgetful of their individual interests, then alone will the association of science with Government yield great benefit and bring about the changes that humanity desires.

Study of Indian Culture in America

WE have received the Bulletin No. 28, May 1939 of American Council of Learned Societies entitled *Indic Studies in America*. It contains the results of a survey of the materials and facilities for study and research in the field of the Indic culture as they exist in American institutions of learning. Details about 218 institutions have been included. They represent museums, libraries and also institutions where instruction is available in languages of India and Greater India and in other related subjects like philosophy, anthropology, etc. A list of literary sources available in the different centres has been appended under carefully classified subjects. The Bulletin is expected to be helpful for students here with reference to the list of museum collections and the bibliography. We draw the attention of our readers in this connection to the article, '*America and Indic Studies*' published in the September, 1940 issue of this journal (Vol. 6, p. 126), contributed by Dr Poleman, director of Indic Studies at the Library of Congress, Washington.

In an introductory article the chairman of the Committee on Indic and Iranian studies says that cultural differences are responsible to dissimilar environmental stimuli and when intercourse between remote parts of the world are becoming increasingly easy we shall need to harmonize the different civilizations. After an able survey of the course of Indian (including Greater India) culture and its contacts with foreign cultures he deplores the fact that there is a great scarcity of materials and available resources for a proper appreciation of the value of the contributions by Indian thinkers and by the Indians as a whole. He concludes that this is the reason why greater attention is being paid for studies of Indian cultural traits and tendencies. These studies offer a vast and fruitful field for research, and will be useful for comprehending the world which is now coming to be and for meeting its needs. They will enrich humanistic study and will furnish materials for the process of rational thinking and understanding.

Meeting of the Inter-University Board

THE sixteenth annual meeting of the Inter-University Board was held at Trivandrum in January last. The proceedings of this meeting, a copy of which we have received lately, show that the work of the Board is gradually becoming important and at the same time heavy. The Board after considering the replies to their questionnaires from the Universities has favoured an I. Sc. course with physics, chemistry (inorganic and organic), botany and zoology with practical examinations as the necessary qualification for entrance to medical course and recommended that there is no necessity of a further premedical course and that the length of the medical course should be five years. To encourage sports on all-India basis the Board is arranging to hold inter-university tournaments. The subjects of study for the matriculation or entrance examinations should be uniform and with a view to securing this the Board appointed a committee who have recommended that the examination should be in two parts. The compulsory group will consist of subjects like elementary arithmetic and algebra, elementary science, history and geography, (the former to be taught not chronologically but by movements or stages in the history of India), in addition to English and a modern or classical language. The second part will consist of subjects from which selection should be made in accordance with the student's aptitude and the course he proposes to take up at the university or elsewhere. Only two papers from one or two groups of this part are to be taken. The recommendation has been cir-

culated to the authorities controlling these examinations all over India. Instead of a single entrance examination for all students to go to universities, the Board is of opinion that secondary education may be diversified for the benefit of those taking up vocational courses, which may be followed after separate entrance tests by similar courses of a progressively higher grade at the university stage so that the students may specially qualify for diplomas and degrees of universities from the school stage. On the recommendation of Calcutta University the Board recommended institution of diplomas and degrees in aeronautics and metallurgy. Besides these, other resolutions have been circulated to universities for opinion. Recommendations on these will be considered at a later meeting.

Annals of Biochemistry and Experimental Medicine

THIS is a new journal, the first issue of which appeared in March last. It will be published quarterly under the auspices of the Indian Institute for Medical Research, Calcutta, for the publication of mainly original papers and also reviews on scientific subjects and books and of reports of scientific interests. The scope of the journal apparently concerns biochemistry and experimental medical subjects like bacteriology, protozoology, etc. In the first issue 16 original papers have been published covering 116 pages. They deal with topics like the effect of vitamin C on the growth of micro-organisms, the nutritional value of the cooked diets, urinary excretion of combined ascorbic acid in pulmonary tuberculosis, enzymes in snake venom, the sulphur-nitrogen ratio in human urine, the argemone oil theory of epidemic dropsy, the ascorbic acid metabolism, nicotinic acid and copper content of fish, mineral constituents of human hair, bowel disorders, blood concentration of sulphanilamide and sulphapyridine, *B. coli* agglutinin in serum of cholera cases and serological experiments with the antigen of *Plasmodium knowlesi* (malaria antigen). As this list shows, the scope of the journal is fairly wide. The papers are of a high standard and considering that there is an editorial board of eminent representative scientists from all parts of India who are concerned in its publication, it is expected that the level of publications will be kept high. The journal no doubt provides a valuable addition to the scientific literature of the world and we hope it will have a prosperous career and receive international attention.

Considering the fine printing and get-up of the issue, the journal appears to be priced very moderately.

Dr H. J. Bhabha, F. R. S.

REUTER informs that twenty new admissions to the fellowship of the Royal Society include Dr H. J. Bhabha, reader in theoretical physics at the Indian Institute of Science, Bangalore, who is described as "distinguished for his contributions to the understanding of the cosmic ray phenomena and the fundamental theory of elementary atomic particles". In the last March issue of this journal we published a short sketch of Dr Bhabha (see pages 500-501).

Franklin Medal to Sir C. V. Raman

THE Franklin Institute of U. S. A. has this year bestowed its highest award, the Franklin medal, upon Sir C. V. Raman in recognition of his researches covering the last quarter century, in particular for his discovery of the Raman effect. After a brilliant academic career in Madras University and few years in the Indian Audit and Accounts Service, Raman joined Calcutta University as the Palit professor of physics in 1917. Since then he established a reputation for this university as an active centre of research in physics. He was made a fellow of Royal Society of London in 1924 in recognition of his valuable theoretical and experimental researches on scattering of light which culminated later in the discovery of Raman effect in 1928. After this, honours were showered upon him in India and abroad. He presided over the Indian Science Congress in 1929. He was awarded the Matteucci medal by the Academie dei Lincei of Rome. In 1930 he was the recipient of the Hughes medal of the Royal Society of London. The same year he was awarded the Nobel prize in physics. For the last few years Sir C. V. Raman has been acting as the head of the physics department at the Indian Institute of Science, Bangalore, where he has already set up a very active school of experimental and theoretical research. Very few foreigners

have been recipient of the Franklin Medal, founded in honour of the great Benjamin Franklin, scientist, philosopher, and politician, who in the last capacity played a very active, nay almost decisive, part in the American War of Independence of 1776. We understand that Sir C. V. Raman is taking a trip to America for receiving the medal. May we not hope he may return with the inspiration of Franklin!

Announcements

At the annual meeting held on the 10th March last, the following gentlemen have been elected office bearers of the INDIAN MUSEUM for the year 1941-42: *Chairman*, Maharaja Sir Prodyot Coomarr Tagore Bahadur, K.C.I.E.; *Vice-Chairman*, Sir Abdul Halim Ghuznavi; *Hony. Secretary*, Mr. A. F. M. Abdul Ali, F.R.S.I., M.A.; *Hony. Treasurer*, Mr. S. N. Bal, M.Sc., Ph.C.

At the Annual Meeting of the ROYAL SOCIETY held on November 30, the following officers and members of Council were elected for the ensuing year. *President*, Sir Henry Dale; *Treasurer*, Prof. T. R. Merton; *Secretaries*, Prof. A. V. Hill and Prof. A. C. G. Egerton; *Foreign Secretary*, Sir Henry Tizard; *Members of the Council*, Prof. P. M. S. Blackett, Prof. F. T. Brooks, Dr C. G. Darwin, Dr A. N. Drury, Dr H. J. Gough, Prof. J. B. S. Haldane, Prof. I. M. Heilbron, Prof. O. T. Jones, Prof. R. T. Leiper, Sir Thomas Middleton, Prof. L. J. Mordell, Dr C. F. A. Pantin, Prof. A. S. Raper, Prof. E. K. Rideal, Dr F. J. W. Roughton, Prof. A. M. Tyndall.

Sir Henry Dale, the new president of the Society is director of the National Institute for Medical Research. For ten years (1925-35), he was one of the secretaries of the Royal Society. He was awarded a Royal medal of the Society in 1924 and the Copley medal in 1937. In 1936 he shared the Nobel prize for medicine with Prof. Otto Loewi of the University of Graz.

SCIENCE IN INDUSTRY

New Use of Colloidal Carbon

RESEARCH workers at the Mellon Institute of Industrial Research, U. S. A., have recently found that colloidal carbon, commonly known as carbon black, is an effective grinding aid in the manufacture of Portland cement. Setting properties of cement and hence the ultimate strength is increased with increasing fineness attained during the grinding process of the burnt clinker, and it has been found that even an admixture of 0.32 per cent. of carbon black in the clinker increases the fineness of the cement by 30 per cent. when the time of grinding is constant, or decreases the grinding time by 28 per cent. when the grinding is run to a fineness as that of the cement without carbon. With an one per cent. addition these improvements become 50 per cent. and 34 per cent. respectively. It has been found further that the addition of colloidal carbon up to the extent of 1 per cent. does not appreciably alter the consistency, settling time, or the soundness of the cement. So it seems that even if the cement is marketed with a fineness as at present there will be much time and power saved simply by adding 1 per cent. of carbon black to the clinker and then grinding. The colloidal carbon used was manufactured from natural gas, with physical and chemical properties similar to the carbon black used in the rubber industry, for which the demand of carbon black is already very high. This new avenue added to the former one will make the manufacture of colloidal carbon a separate industry by itself.

N. K. S. G.

Jute Plants in Russia

THE recent *Bulletin* of the Indian Central Jute Committee contains a report that the All-Union Institute of Plant Cultivation has for the past 13 years been carrying on experiments in the cultivation of jute in the U. S. S. R. and has proved that this important industrial crop can be grown successfully in the Soviet Union. From among 150 varieties imported from India and various other tropical and sub-tropical countries and planted by the Institute in

certain districts of Trans-Caucasia and Central Asia, the varieties *Corchorus capsularis* and *Corchorus olitorius* have been selected. These plants yield 13 to 25 per cent. of fibre, and produce a crop of seeds, which will make it possible to cultivate jute in the U. S. S. R. on an industrial scale. At present the Institute is trying to acclimatize varieties with a greater yield.

Another report hints at a possible artificial development of fibres. In case of bean plants it has been observed that after the leaves and stems are sprayed with naphthaleneacetamide the increased cambial activity in the stem results in a relatively larger amount of secondary thickening of the fibre walls. Research for similar response in flax, hemp and jute deserves consideration.

Rot-Proofing of Sandbags

It is well known that bags filled with sand or soil when exposed to weather are particularly liable to rot and finally crumble down. Especially during this wartime, when a large number of sandbags are being used for protecting buildings, trenches and for other defence purposes, it is of utmost importance to increase the life of sandbags. For the last two years, Imperial Chemical Industries Ltd., was engaged on this problem and has developed a very cheap and simple process for the protection of the sandbags. It consists of dipping the bags in two common chemicals, sodium carbonate and copper sulphate, so that the fibres become saturated with a basic copper carbonate suspension. Two processes have been developed, "One-bath process" and the "Two-bath process" depending upon whether the copper sulphate and the sodium carbonate solutions are mixed beforehand and then the bags dipped, or the bags are dipped successively in their separate solutions. Equally good results are obtained by both the processes but the one-bath process is simpler to use; but in treating compact and tightly woven materials, or sandbags in compressed bales, it may be preferable to use successive immersions of copper sulphate and sodium carbonate. It is the copper which gives resistance to rotting.

The bags must be treated before they are filled with sand. No rot-proofing process is satisfactory when applied to bags already in place. Particular care must be taken to treat the thread used for seams, as it is often here that the rotting begins. It has been estimated (in England) that treatment with this mixture at the present price does not cost more than one-tenth of a penny per bag of normal size.

N K. S. G.

Expansion of India's Industries

It is understood that plans for expanding the manufacture of weapons and ammunition and for enlarging and erecting ordnance factories are being discussed with members of the Supply Mission.

A 2,000 ton gun forging press, which will be the largest of its type in India, has been received for the Metal and Steel Factory, Ishapore. Several important items of plant required for the expansion of ordnance factories have also arrived in the country.

A Duosol plant for the production of aero-engine lubricating oils will be soon erected under the Attock Oil Company. As a result of experiment with the new all-scrap acid process a new source of supply of 400 to 500 tons per month of acid steel of medium and high carbon grade has been established.

Production of canned fruits, vegetables and jams is being developed and samples have been approved as suitable for Defence Services. Anti-anthrax serum for veterinary use is now produced according to demand at the Imperial Veterinary Research Institute, Mukteswar.

Wind in the Generation of Electricity

WIND power is being harnessed in an unprecedented scale for generating electricity in U. S. A., according to a short note in the *Journal* of the Franklin Institute. This experimental vento-electric station has been initially designed to produce 1000 kilowatts. After elaborate meteorological investigations the site has been selected on a mountain top and is expected to provide a steady wind factor. It is proposed to unite in a power line a number of vento-electric stations with reservoir-fed hydro-electric generators. The new project has required not only current research in aerodynamics and meteorology but also a great deal of recent engineering developments of numerous industries have been brought to bear upon it. The principal problem has been to provide the generating unit with accurate speed regulation and patentable developments are claimed in this respect.

Concentrated Nutritional Food

A FOOD supplying an optimum of all nutritive requirements of a normal person has been developed in the department of biology and public health of the Massachusetts Institute of Technology, by Professor R. S. Harris and H. B. King, says the *Technology Review*, December, 1940. It is stated that the formula was established after a study of the various nutritive elements missing from the diet of the low-income group of peoples. The food is composed of cereals, including wheat, corn, oats, and soya-bean meal, to which are added the required amount of various minerals and concentrates. The food contains only the nutritive elements and not the energy and water supplying elements. It has been assumed that the energy and water supplying elements are sufficiently present in the ordinary diet, but the nutritional elements are not met by the average unbalanced menu. Vitamin C has also not been included in the formula since it has been assumed that it can be supplied by a daily ration of 4 ounces of tomato juice. The most interesting feature of the new food is that of the cost. It is claimed that this food could be prepared at a cost per person of \$1.80 (nearly Rs. 6/-) a year. Certainly this food will be most welcome in a country like ours where the income per capita is very poor with a consequent deficiency of the nutritional elements in the normal diet.

N K. S. G.

Wax from Castor Oil

E. I. du Pont de Nemour & Co. U.S.A., has developed a process for preparation of wax by the catalytic hydrogenation of castor oil. It has been named "Opalwax" and is comprised essentially of 12-hydroxy stearin, and having unusual physical and chemical properties. It is practically odourless, pearl-white in colour, has an apparent specific gravity of 0.98 to 0.99 at 20°C., is extremely hard, and has an acid number of less than 2. Opalwax is extremely insoluble in solvents. None of the common solvents has been found to dissolve as much as 2 per cent. of the wax at temperatures up to 30°C. Sulphuric and nitric acids at high concentrations have got some action on it. It is claimed that it can be used as a substitute for ordinary wax.

N K. S. G.

Potatoes in India

POTATOES form a common article of diet but the most regrettable feature of this crop in India is its abnormally low yield. Its cultivation and other related

factors have been reviewed in the recently published report of the Agricultural Marketing Adviser to the Government of India. Apart from domestic consumption potatoes are now utilised in industries in other countries for the manufacture of starch, dextrin, glucose and alcohol. The report is very informative and the whole subject of potato cultivation and marketing has been divided into thirteen chapters.

A century ago potato was comparatively unknown in India, but today it is probably the most widely grown of all the vegetables. It is an important money crop being worth about nine and a half crores of rupees. The share of India however both in world acreage and production is very small being less than one per cent. in each case. The annual imports into India are considerable and average in recent years about $11\frac{1}{2}$ lakh maunds valued at over Rs. 33 lakhs. The total area under potatoes in India during the five years ending 1939, is estimated at 448,700 acres, of which about 90 per cent. are estimated to be grown in the plains (including the Deccan) and the remainder in the hills. Most of the varieties commonly grown in India have been imported in the past from Europe and North America. The so-called *desi* varieties are also considered to be imported varieties which have become acclimatised and of which the original names have been lost. Apart from the imported seed, the total quantity retained for seed purpose out of Indian production amounts annually to 7,932,200 maunds or 16.1 per cent. of the total annual production. Bihar is the most important province in this respect and accounts for nearly half the total quantity. Potatoes either for seed or table use are imported mainly from Burma, Italy and Kenya Colony. The heavy imports from Burma, Italy and Kenya Colony clearly indicate a shortage of production in India. These are, however, received during the period when Indian supplies are low.

Until a few years ago, very little attention had been paid to potato research. Recently however, there has been a welcome change and, under the aegis of the Imperial Council of Agricultural Research, the work of potato research has been considerably stimulated. India has a vast area of agricultural land suitable for the production of potatoes, but in spite

of such potentialities its annual production is very low and wastage due to disease and other factors is high. Problems relating to the nature and quality of seed requirements under different soil and climatic conditions, improvement in yield and prevention of diseases, and loss during storage should form important items in the programme of research work. Apart from the damage due to diseases and insect pests, considerable loss is sustained in storage on account of the rotting of tubers during the summer months. The problem of storage has lately received some attention in some of the provinces and States but it cannot be said to have been satisfactorily solved. Storing at a low temperature is the most successful method of minimising loss in storage. Loss could also be considerably reduced if varieties capable of withstanding high temperatures are evolved.

Jute as a flax substitute

So long many substitutes for jute have been produced and, on the other hand, researches have brought forth new uses of jute. A recent report states that jute by chemical treatment may be used in place of flax. The Woodburn Dyeing and Furnishing Co., of North Ireland have discovered this new process. Jute is treated chemically so as to make it more sensitive to bleaching dyeing and the like and at the same time rendering it more resistant to bacterial decay. 'Celin' as the resulting product is commercially called, can be spun, woven and finished on orthodox flax machinery. It is being made on a manufacturing scale and sold at £65 per ton. After chemical treatment which requires only a few days, it is rolled into the required degree of softness, dried and cut into short lengths. No batching oil need be applied, Celin has no odour of jute products. It is quite soft like wool and can be spun on worsted machinery. It can be readily bleached to $\frac{3}{4}$ white and no pre-boiling is necessary. Canvas has been made of Celin warp and weft, and the goods have been approved by the government departments. They are superior to union fabrics of jute and cotton made in India. A coloured towel was perfectly all right after 150 washings.

Manufacture of Synthetic Drugs in India*

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THE latest figures of 1938-39 relating to the import of synthetic drugs, related fine chemicals and dyes indicate that India purchases every year drugs and medicines including disinfectants to the value of about Rs. 228 lakhs. No separate entries have been made in the report of the *Sea-borne Trade Journal* for any individual drug or medicine, excepting a few items such as camphor, cocaine, naphthalene and glycerine. Under the present war conditions of the world in all cases the prices have gone up very high, and some drugs are not at all available for any price. It is an imperative necessity that we should find means to produce these substances in this country. In undertaking the preparation of these substances in this country, the question of finding the required basic materials becomes a matter of fundamental importance.

A factory, which will deal with the preparation of synthetic drugs, should also undertake the preparation of other useful fine chemicals as the operations involved are so close and connected that the manufacture of these can very economically and profitably be undertaken side by side. There is no doubt whatsoever that facilities by way of the requisite starting materials and technical knowledge are available in much greater measure today than during the last Great War. But, all such enterprises, however well conceived and designed, are likely to collapse ultimately if a steady protective policy is not vouchsafed to them by the Government after the war ends. In his presidential address delivered at the Indian Science Congress this year Sir Ardeshir Dalal rightly remarked :

"No institution, however well conceived and designed, can flourish except in suitable political atmosphere and conditions. It was the unfortunate experience of the last war that industries created under the stress of the war languished and died in the post-war period for want of encouragement and protection from Government.

The activities of the Board† will not lead to the creation of new industries unless industrialists are assured of reasonable protection from Government in the post-war period, when foreign competition will be keen."

PLANTS AND EQUIPMENTS

The drug manufacturing industry requires first vessels of iron, steel, aluminium, and copper to deal with the crude products. All these metals are available in the country and it should be possible to construct the requisite equipments (if necessary with protective layers of other metals) without much difficulty with the help of the trained engineers. Operations involving the use of corrosive liquids and acids will require porcelain, enamelled or glass-lined vessels. The few existing porcelain, enamel and glassware producing concerns should be induced to undertake the manufacture of such equipments. Any research that may be necessary in this connection should be undertaken forthwith. In many cases, the final operations will have to be conducted exclusively in glass vessels. Fortunately large size glass vessels are being successfully made at present in India by the Scientific Indian Glass Co., Ltd., Calcutta, and possibly by a few other firms, and they will only welcome the extension of opportunities for further development of their activities.

It may not be possible, at any rate to begin with, to buy or construct large scale plants necessary for the production of these chemicals. Due to war conditions, it is not possible today to get any of these plants and machineries from outside. On the other hand, from the materials and workmanship available in India, it should be possible to build up small units of equipment for preparing these chemicals on a semi-large scale basis to begin with. If it becomes necessary to increase the production, either these small units may be multiplied in number or large size plants constructed. Control of processes will be

* Based on a lecture delivered under the joint auspices of the Chemistry Section of the Indian Science Congress and the All-India Pharmaceutical Conference on January 8, 1941.

† Reference is here to the Board of Scientific and Industrial Research.

easy with small units, risks will be less, and high engineering knowledge may not be very essential. Added to this, all money spent in constructing these small units will be retained in India. Systematic investigation into the metallurgy of ferrous alloys such as tantiron, antac iron, duriron, durichlor, ironac, hastelloys, "Stainless" 18:8 steels: VA steels, Ni-resist, everdur, armstrong alloy, etc., suitable for the handling and manufacture of fine chemicals and drugs etc. should be undertaken at the earliest possible opportunity in this country.

PROCESSES AND OPERATIONS

A few observations on the nature and variety of unit operations required in this kind of industries will not be out of place. Unlike the heavy chemical industry and factories for the production of sugar or soap, fine chemical industry is not one where a single plant can be set up and the product turned out on tonnage basis. As the number of chemicals required in the preparation of synthetic drugs is very large and the processes involved are also numerous, separate unit experiments will have to be set up for every class or type of operation. In every case the plant, machinery and apparatus etc. have to be individually chosen, depending on types of reactions, capacity, durability and installing cost. The principal processes involved are (1) nitration, (2) amination, (3) sulphonation, (4) halogenation, (5) oxidation, (6) reduction, (7) alkylation, (8) acylation, (9) diazotisation and coupling, (10) esterification, (11) hydrolysis, (12) decarboxylation, (13) electrolytic operations, (14) catalytic processes, (15) different kinds of condensations, (16) effecting unsaturation, (17) addition reactions, (18) ring closure, and (19) ring opening, etc.

The economics of chemical manufacture lies in the successful recovery and utilisation of by-products. In the preparation and purification of organic chemicals the use of solvents is very common, and the right choice of which for a particular reaction and an expedient recovery of the same is essential.

RAW MATERIALS

It is well known that the sources of raw materials necessary for the production of these synthetic preparations are products chiefly derived from coal tar, petroleum, wood distillation and fermentation industries; in some cases animal and vegetable products also form useful starting materials. Although plenty of coal tar is available from coke ovens and other gas companies, little systematic attempt has yet been made to recover the various valuable products contained in them. Solvents like alcohol, fusel oil, glycerol and various glycols form

the products of fermentation industry. At present ethyl alcohol is perhaps the only item produced by this process in India by the fermentation of molasses. Excepting coal tar and petroleum which are available only in selected areas, most of the other raw materials mentioned above are available in many parts of India. India's potentiality with regard to oils and seeds is enormous and well established.

INORGANIC REAGENTS

In the process of preparing or synthesising organic chemicals like drugs, inorganic reagents are required almost at every step and operation. Therefore, in addition to the availability of organic raw materials, we have to look for the availability of the inorganic chemicals. Amongst others, special mention should be made of ordinary mineral acids, caustic alkalis and alkali carbonates; sulphur, phosphorus, arsenic, antimony and their derivatives; halogens and their acids; ammonia, sodium, silver, lead, mercury, copper, tin, bismuth, iron, nickel, aluminium, zinc, calcium, magnesium, platinum, palladium, selenium, and their oxides and salts, alloys and amalgams. Sources of supply of most of these chemicals occur in the mineral resources of the country, and a few heavy chemicals like mineral acids, alkalis, and salts are already being manufactured in this country. Inorganic chemists in India should immediately undertake research on the preparation of important inorganic reagents required for drug manufacture, such as sodium, SO_2 , SOCl_2 , chlorosulphonic acid, red and yellow phosphorus, P_2O_5 , PCl_3 , PCl_5 , POCl_3 , I_2 , Br_2 , etc.

LABOUR: SKILLED AND ORDINARY

From the Indian universities, it is possible to gather an army of qualified scientific men. The research experiences also have advanced so much that India may hope to be self-sufficient so far as skilled labour is concerned. The lack of opportunities for want of sufficient industrial development of the country is one of the chief reasons for the unemployment of our graduates. With the teeming millions of labourers available in India, much of the ordinary mechanical work done by machineries in other countries could be done at the initial stages by means of man power. Not that machine power wherever available should not be welcome but the utilization of manual labour will, to a certain extent, provide a means of livelihood for our unemployed labourers.

NEED FOR RESEARCH

It is a matter of common experience that the various methods described in the literature in-

cluding patent specifications for the preparation of drugs appear so conflicting and un dependable in practice, that it becomes essential to find out by actual experimentation the best method and conditions necessary for their convenient production in good yields. The selection of the method is to be made keeping in view of the ease and convenience with which the requisite starting materials can be made available in this country, and thus these preliminary experiments themselves will be of fundamental importance and utility. Having found out the method, the process is to be tried in a small pilot plant before trying it in the final large scale plants.

IMPORTANT DRUGS

The following is a list of useful and important drugs (selected in consultation with medical practitioners and firms) whose manufacture should be started in this country without delay.

ANTISEPTICS AND DISINFECTANTS: 1. Phenol, 2. Salol, 3. *Resorcinol*, 4. *Guaiacol*, *Guaiacol carbonate*, *Guaiacol potassium sulphate*, 5. *Thymol*, 6. β -*Naphthol*, 7. *Tribromophenol*, 8. *Iodoform*, 9. *Formaldehyde*, 10. *Hexamine*, 11. *Chloramine T*, 12. *Acriflavine*, 13. *Dermatol*, 14. *Protargol*, 15. *Methyl violet*, 16. *Crystal violet*, 17. *Auramine*, 18. *Rivanol*, 19. *Rhodamine*, 20. *Chinosol*, 21. *Brilliant green*, 22. *Malachite green*, 23. *Trypan red*, 24. *Trypan blue*.

PURGATIVES AND APERITIVES: 1. *Phenolphthalein*, 2. *Orexin* (*phenyldihydroquinazoline*).

DIURETICS AND URIC ACID SOLVENTS: 1. *Caffeine*, 2. *Piperazint*, 3. *Atophan*, 4. *Salyrgan*, 5. *Theophylline*, 6. *Theobromine*.

VASO-CONSTRICTORS: 1. *Adrenaline*, 2. *Ephedrine*, 3. *Benzidrine*, 4. *Alkaloids of Ergot*: *Ergotoxin*, *Ergotamine*, *Ergometrin*, *Ergotinine*, *Tyramine*.

VASO-DILATORS: 1. *Amyl nitrite*, 2. *Ethyl nitrite*, 3. *Nitroglycerine*, 4. *Octyl nitrite*.

ANTIPYRETICS AND ANALGESICS: 1. *Acetanilide*, 2. *Phenacetine*, 3. *Benzoic acid*, 4. *Salicylic acid*, 5. *Aspirin*, 6. *Antipyrine*, 7. *Pyramidone*.

NARCOTICS AND GENERAL ANAESTHETICS: 1. *Cyclopropane*, 2. *Ether*, 3. *Para-aldehyde*, 4. *Acetophenone*, 5. *Chloroform*, 6. *Urethane*, 7. *Adaline*, 8. *Chloralhydrate*, 9. *Chlortone*, 10. *Avertine*, 11. *Veronal*, 12. *Luminal*, 13. *Evipan*, 14. *Sulphonal*, 15. *Trional*, 16. *Tetronal*.

LOCAL ANAESTHETICS: 1. *Ethyl chloride*, 2. *Anaesthetics*, 3. *Novocaine*, 4. *Cocaine*, 5. *Eucaine*.

ANTI-PROTOZOAL AND ANTIBACTERIAL DRUGS:

1. *Atoxyl*, 2. *Tryparsamide*, 3. *Carbarson*, 4. *Neo-salvarsan*, 5. *Stovarsal*, 6. *Sulpharsenol*, 7. *Solusalvarsan*, 8. *Mapharside*, 9. *Urea Stibamine*, 10. *Neostibosan*, 11. *Neo-cardyl*, 12. *Mercurochrome*, 13. *Merthiolate*, 14. *Emetine*, 15. *Yatren*, 16. *Vioform*.

ANTIMALARIALS: 1. *Quinine*, 2. *Euquinine*, 3. *Aristoquinine*, 4. *Plasmoquine*, 5. *Atebrin*.

SULPHANILAMIDE GROUP OF DRUGS: 1. *Sulphanilamide*, 2. *Prontosil*, 3. *Prontosil sol.*, 4. *Proseptazine*, 5. *Soluseptazine*, 6. *Rhodilone*, 7. *Uleron*, 8. *Albucid*, 9. *Dagenan*, 10. *Sulphathiazole*.

MISCELLANEOUS DRUGS: 1. *Camphor*, 2. *Coramine*, 3. *Glycerophosphates and choline hydrochloride*, 4. *Cardiazole*, 5. *Cantharidine*, 6. *Calcium gluconate*, 7. *Aulinogen*, 8. *Sulphoform*, 9. *Solganol*, 10. *Mandelic acid*, 11. *S. V. P.* 36.

HORMONES: 1. *Adrenaline*, 2. *Thyroxine*, 3. *Insulin*, 4. *Androsterone*, 5. *Testosterone*, 6. *Oestrone*, 7. *Progesterone*, 8. *Stilbosterol*.

VITAMINS: 1. *Vitamin A*, 2. *Vitamin B₁*, 3. *Vitamin B₂*, 4. *Vitamin B₆*, 5. *Nicotinic acid*, 6. *Vitamin C* (*Ascorbic acid*), 7. *Vitamin D*, 8. *Vitamin E*.

Work has been and is being done in the writer's laboratory on a few of these drugs, which have been italicised in the list given above, both in relation to the production of the requisite starting materials as also the finished products.

Synthetic drugs have to be subjected to pharmacological and clinical tests before releasing them for medical use. It is pitiable that sufficient facilities for such tests are not available in our country. However, it is gratifying to note that the Indian Institute of Science at Bangalore has made a beginning in this direction by opening a section of pharmacology, where synthetic drugs produced will undergo pharmacological and clinical test.

LEGISLATION

There should be complete governmental protection afforded for all indigenous industries. This can be achieved by (i) raising the tariff rates for all imported substances, if necessary for a restricted period, (ii) withdrawing duties on solvents like benzene, petrol, alcohol, etc. and other raw materials required for drug manufacture, (iii) encouraging a policy to purchase as far as possible drugs and chemicals made in India, (iv) providing transport facilities, by bringing down freight charges for transport of raw materials and finished products, which is very necessary because of the vastness of India so that these products may reach all parts of the country.

MEDICINE & PUBLIC HEALTH

Deficiency of Vitamins C and P in Man

Bentsath *et al* (*Nature*, 138, 798, 1936) observed that the survival time of guineapigs kept on a scorbutic diet could be prolonged from 28.5 to 44 days by the administration of vitamin P. At autopsy the animals receiving supplements of the vitamin showed significantly fewer haemorrhages. The authors therefore concluded that the haemorrhages of scurvy were partly due to the absence of vitamin P and scurvy was the result of the combined deficiency of vitamin C and vitamin P. Zilva however observed (*Biochem. J.*, 31, 915, 1937), that the postmortem appearance described by Bentsath *et al* could be reproduced by the administration of minute amounts of vitamin C (0.1 mg. daily) and contradicted the existence of vitamin P. Scarborough (*Biochem. J.* 33, 1400, 1939) observed that a diminished capillary resistance was present in people getting a deficient supply of vitamin P and the capillary resistance could be increased by the administration of vitamin P and not by vitamin C. Zacho (*Acta path. microbiol. scand.*, 16, 144, 1939) confirmed the observation of Scarborough in experiments with guineapigs. In scorbutic guineapigs capillary resistance could be increased solely by the administration of vitamin P. Recently Scarborough (*Lancet*, 2, 644, 1940) has reported the existence of vitamin P deficiency in man receiving a liberal supply of vitamin C. Symptoms of vitamin P deficiency include pains in the leg on exertion, pain across the shoulders, weakness, lassitude and fatigue. Capillary resistance is much diminished. Spontaneous minute petechial haemorrhages usually occur. Large haemorrhages under the skin, muscle and gums, characteristic of vitamin C deficiency are not seen. Blood picture is normal. All the signs and symptoms are alleviated after the administration of vitamin P.

S. B.

Oral Anterior Pituitary Extract in Diabetes

Anterior lobe of the pituitary gland liberates a hormone which causes an increase in the blood sugar level. Normally this diabetogenic action of the

anterior pituitary is checked by insulin. Recently Collip (*Canad. Med. Ass. Jour.*, 42, 109, 1940; *Amer. Jour. Physiol.*, 229, 338, 1940) has claimed to have obtained an alcoholic extract of the anterior pituitary which has antidiabetogenic properties like that of insulin. Lawrence and Young (*Lancet*, 2, 70, 1940) studied the effect of alcoholic extract of the anterior lobe of the pituitary (Collip) on human diabetic patients and on dogs made diabetic by the administration of anterior pituitary extract. No change in the blood sugar level was observed which showed that these extracts have no action on carbohydrate metabolism. Collip suggested that his extract exerts its effect by virtue of a 'pancreatotropic action'. Marks and Young (*Lancet*, 2, 710, 1940) administered Collip's neutral alcoholic extract of pituitary to rats by subcutaneous injection or by mouth. No significant increase in the insulin content of the treated rats was observed by them.

S. B.

Renal Excretion of Inorganic Phosphate

When phosphate salts are administered intravenously they are filtered by the glomerulus of the kidney and in their passage through the renal tubules all reabsorption of phosphates takes place. Under standard conditions there is a limiting maximal rate of reabsorption of phosphate by the tubules and the excess is excreted in the urine. Administration of vitamin D in dogs kept on a vitamin D-free diet produces a marked increase in the maximal rate of reabsorption of phosphate by the renal tubules and a rise in the phosphate content of the plasma. Reverse effect is observed when parathyroid extract is administered. (Harrison *et al*, *J. Clin. Invest.*, 20, 47 1941).

S. B.

Mechanism of Diuresis in Heart Failure

In cases of heart failure there is accumulation of fluid in the tissues because the kidneys do not function properly. The circulatory renal system consists of the kidneys on the one hand and the tissues which

retain fluid on the other, the circulating blood connecting them. Tissue fluid to be excreted as urine must be carried by the blood to the kidneys. Diuresis may be effected in two ways. Kidneys may secrete urine from the blood which will then become concentrated and as a result will draw fluid from the tissues or the tissue fluid may enter blood which will then become diluted and then the kidney will excrete the excess water. In the former case the specific gravity of the blood will rise and in the latter case it will be just the reverse. Stewart (*J. Clin. Invest.*, 20, 1, 1941) observed the specific gravity of the blood plasma in instances of diuresis occurring spontaneously without the use of drugs (8 patients), in diuresis resulting from digitalis (9 patients) and in diuresis following the use of theocalcin (5 patients). In all the cases it was observed that diuresis depended on changes initiated in the tissues, since it was accompanied by decrease in specific gravity of the plasma, i.e., by dilution of the circulating blood with an increase in the blood volume. Dilution of blood preceded the onset of diuresis. The specific gravity of the plasma must fall from a high level to 1.0255 or lower for the initiation of diuresis. Plasma protein deficiency does not participate in the etiology of cardiac oedema.

S. B.

Death of Sir Frederick Grant Banting

An accident to the plane carrying Sir Frederick Grant Banting to England on a mission of high scientific importance resulted in the catastrophic death of this eminent investigator. He was going to demonstrate, it is said, a method of nullifying the effects of poison gas. It is understood that his formula was made known to others before his departure and hence there are prospects of salvaging the work which is reported to be "as great, if not spectacular, as his discovery of insulin."

To Banting mankind will remain grateful for insulin which is saving the lives of many diabetic patients and allowing them to lead a normal life. Due to degeneration of pancreas, the active principle of this internally secreting gland becomes unavailable and the carbohydrates of the food of the diabetic patients are not efficiently metabolised. In 1889 researches had shown that removal of the pancreas from animals resulted in a disease with almost identical symptoms. Banting and Best in 1921 discovered that insulin is produced in the pancreas and later they separated it. Patients were first treated with this substance in January, 1922. Now it is obtained in bulk from the livers of slaughter-house animals and prepared for use.

Banting was born in 1891 at Ontario, Canada. He received his medical education at the University of Toronto where he graduated in 1916. After serving during the war in Canada, England and France (1915-19), and further education at London he began to practise medicine there. At the time of his death he was professor of medical research at Toronto. While a lecturer in pharmacology in Toronto University he began his research on the internal secretion of pancreas. This work on insulin secured for him the Nobel prize in medicine in 1923, jointly with Dr Best and Prof. J. J. R. Macleod. The complete work was an example of a large team work and the research workers after patenting the discovery presented the patent rights to Toronto University. The University later gave the British patent to the Medical Research Council of Great Britain.

Early Bacteriological Research in India

The important part that India has played in the development of the science of bacteriology was referred to by Major C. L. Pasricha, I.M.S., professor of bacteriology and pathology, School of Tropical Medicine, Calcutta in a paper on the history of bacteriology and some of the early workers in India read before the Royal Asiatic Society of Bengal. Out of 330 early workers in bacteriology, the presence of epidemic diseases in India and the facilities for large scale trials under controlled conditions provided opportunities for a large team of 17 to carry on their investigations on Indian soil. These were Henry Vandyke Carter (British); David Douglas Cunningham, (British); Stewart Ranken Douglas (British); Bernhard Fischer (German), member, Cholera Commission to India, 1888; George Gaffky (German), member, Cholera Commission to India; Waldemar Mordecai Wolff Haffkine (Ukrainian), cholera and plague expert and founder of the Haffkine Institute, Bombay; Ernest Hanbury Hankin (British), chemical examiner and bacteriologist, United Provinces and Central Provinces; Felix Hubert d'Herelle (Canadian), cholera and dysentery specialist; Robert Koch (German), head of the German Plague Commission to India, 1896; George Lamb (British); William Boog Leishman (British); Timothy Richards Lewis (British); Alessandro Disting (Italian), authority on plague; Charles James Martin (British), member, Plague Advisory Committee; Richard Pfeiffer (German), member, German Plague Commission in India; Sydney Domville Rowland (British), member, Advisory Committee for Plague Investigation in India; and Almroth Edward Wright (British), member, Indian Plague Commission. Each one of them has left an indelible mark upon the annals of research and discovery in relation to infectious diseases of both men and

animals. Their experiments have contributed largely to the establishment of the value of vaccines as prophylactic agents in the controlling of large epidemic diseases, and subsequent workers are under deep debt for their large assembly of data and their development of the methods of application of scientific tools in solving bacteriological problems.

Biological Applications of Synthetic Chemistry

Under the above title, Prof. W. J. Cook of Glasgow University, has reviewed some recent applications of chemistry to biological problems, which have been of outstanding importance.

Many rare compounds not known in nature and yet possessing powerful biological activity have arisen from the creative efforts of synthetic chemists. Sulphonamide drugs are a great boon to mankind against various infections and these are the outcome of purely chemical investigations. New products have also been produced with therapeutic and pharmacological properties resembling and sometimes exceeding those of natural plant products. The use of procaine is an example of these. This synthetic substitute of cocaine has caused a rapid decline in the

use of the latter as an addiction drug. This has given a stimulus to solve the problem of drug addiction.

With regard to chemotherapy a recent line of work is in connection with tubercular infection. The object is to find out an agent capable of penetrating or breaking down the waxy envelope surrounding the bacilli of the infection. The cue is taken from the treatment of leprosy. In case of leprosy it has been found that the leprocoidal activity of the chaulmoogra oil long used in its treatment is due to its active component of a cyclopentenyl fatty acid. This and later synthetic analogues of chaulmoogric acid impair the function of the fatty envelope of the organism and cause decay of the bacilli.

The discovery of vitamins, members of the sterol class and of hormones has elucidated many physiological problems. This has been possible due to isolation and identification and synthesis by the chemists of some of the vitamins. Though total synthesis of all the hormones has not yet been possible, common degradation products have been prepared. Deoxycorticosterone, the most active hormone in adrenal cortex, which has been isolated from ox adrenals and is now prepared artificially, has been observed to be the vital factor for maintaining sodium chloride balance in the blood. It is now used effectively in the treatment of wound shock.

Blood Transfusion

FEODOR KANDYBA

In 1492 Pope Innocent VIII, then of an advanced age, fell into a condition which made it impossible for those in attendance upon him to decide whether he was alive or dead. All medical treatment proved of no avail. Then a doctor, whose name has not been handed down to posterity, appeared and declared that he could heal and rejuvenate the old man if only he could obtain the fresh blood of a youth. His proposal was accepted at once and three healthy young men came to an untimely end, but the new doctor's treatment did not save the Pope's life. He died soon after the youths.

The restoration of life and health through the medium of transfusion of blood has been dreamed of for centuries. In ancient Greece myths sprang up around the name of Medea, who could make people young and beautiful by transfusing new blood into them. Yet all attempts to realize this dream

ended in disaster. In the Middle Ages many experiments were made to restore youth to the aged through the blood of infants, but both the young and the old died as a result. Sometimes the blood of animals was transfused into people, but this too often was a failure.

Yet the idea itself was right. After William Harvey discovered in the seventeenth century the laws of the circulation of the blood, it sometimes happened that doctors obtained very remarkable results with blood-transfusions; the dying were actually restored to life. Oftener than not, however, patients paid with their lives for the doctors' experiments.

It was only at the beginning of the twentieth century that this method of healing was placed on a scientific basis. Soon it became a very effective treatment and at the present time is applied practically

everywhere and saves the lives of thousands of the sick and wounded.

The human body holds from five to six litres of blood. If a man loses more than half of this quantity he will die for lack of the oxygen which is contained in the red corpuscles (erythrocytes), and the nourishing substances in the plasma or fluid part of the blood. Failure to replace the loss by transfusion of another person's blood is accounted for by the fact that the serum of some bloods contain substances that agglutinate or clump the red corpuscles of certain other bloods. The clotted erythrocytes block up blood vessels that are essential to life and the patient dies.

Such was the state of affairs until three scientists—the German Landsteiner, the Czech Janski and the American Moss established that there are four groups* into which the blood of man may fall, and that one of the four kinds of blood cannot in all cases replace the other. These groups are commonly represented by the Roman figures I, II, III, IV, and it has been found that approximately forty per cent of people belong to the first group; their blood can be transfused to anyone. These people are known as universal donors. The blood of the other three groups can only be transfused in definite combinations, according to the laws of compatibility discovered by the above-named scientists.

A quick and exact method of determining the group to which a person belongs has been worked out with the aid of standard serums; it takes not more than five minutes and only a few drops of blood from the finger are needed. In consequence, transfusion has been rendered safe and was brought into wide use, especially during the World War of 1914—1918, when American doctors saved the lives of thousands of soldiers by this method.

The first successful blood transfusion was made in Russia in 1832 by Dr Wolf, who saved the life of a woman almost dying in childbirth. One of the pioneers in this field was Professor Khotovitsky, the surgeon, who worked out, over eight years ago, a method of transfusion, gave a detailed description of the process and even invented a special apparatus for it. Other Russian surgeons, Buyalsky, Kolomin and Filomafitsky, also added much that was new to the science of blood-transfusion. The discoveries and suggestions made by gifted doctors in isolated instances were not acted upon, however, in old Russia and the method of treatment did not become widespread before 1917.

Then Soviet medicine had to begin from the very beginning in this field; the whole of the elaborate methodological work on the determining of the groups and preparation of the standard sera for each group was done over again by Drs Shamov and Yelansky, now professors in the Leningrad Army Medical Academy. They were repeating what had already been done in the West, but since communication with scientists abroad was temporarily broken off—there was no help for it. The first transfusion was made by Dr Shamov in the summer of 1919. Since then a great deal of work has been done on this problem, and the U.S.S.R. has overtaken those countries where transfusion is being applied on an ever-widening scale.

In 1926 the Central State Institute of Haematology and Blood Transfusion was organized in Moscow. There are branch institutes all over the country. The work has been greatly extended. At present there are special clinics—about one thousand five hundred altogether—in every regional and many district centres, and this does not include the hospitals, where transfusion is done as a matter of course. In 1939, 140,290 blood transfusions were made in the U.S.S.R., which now heads the list in this respect.

In other countries the operation is always expensive and only the well-to-do can afford to pay for living blood taken from another person. American donors belong to special unions, the members of which live solely upon the sale of their blood and are not allowed to take up any employment. In the U.S.S.R. blood transfusion is free to anyone who requires it.

An operation of this kind will save a life in cases of serious accidents in the street, factory or field, or of severe bleeding in difficult childbirth, or haemorrhages of the stomach, kidneys or intestines. Blood transfusion is also resorted to in operations involving great loss of blood. Doctors find it useful, not only as a means of replacing blood that has been lost, but also as a cure in many diseases. Just now it is being successfully applied in cases of exhaustion following on infectious diseases, in chronic anaemia, severe burns, ulcerated stomach, colitis and certain eye-diseases. A number of cases exist of suppurating ulcers, affections of the joints, and inflammation of the lungs, cured with the aid of blood transfusions; the new blood introduced into the sick or wounded patient not only replaces that which has been lost, but stimulates the weakened constitution. As a result, the activity of all the functions is increased and new strength for the struggle with disease is acquired with the new blood. The albuminous particles of the latter produce a complex reciprocal

* See SCIENCE AND CULTURE, 6, 474, 1940-41 for an account of these groups in the article "Blood Groups for Everybody: The Four Groups."

action when they come into contact with the patient's own blood; the old, worn-out particles in the cells coagulate, settle in the form of a sediment, then dissolve and are carried out of the constitution by the blood. The products resulting from the disintegration of the outworn albuminous particles of the cells stimulate the metabolic processes and all the functions. Such is, in essence, the theory by which Professor Bogomolets explains the mechanism of the action of transfused blood.

Formerly blood was conveyed directly from donor to patient by a special syringe and a system of tubes connecting the blood-vessels of the elbows. This method is hardly ever used now in the U.S.S.R. The operation is carried out in a much simpler and more convenient way; the donor's blood is collected in a jar containing a solution of sodium citrate to preserve it from coagulating, and kept in a refrigerator until required. Scientific research has discovered a method of keeping blood taken from donors for twenty days and more. The refrigerators where the stocks of blood of all four groups are kept work day and night. The telephone rings, the dispenser on duty takes out a jar of blood of the required group and in a few minutes' time the ambulance has delivered it at the hospital, clinic or maternity home where it has been called for to save a life. Needless to say, thousands of human lives are rescued from the clutches of death as a result of this excellently organized system of blood transfusion.

It is an extremely popular method of treatment in the U.S.S.R. and its technique has been so far perfected and simplified that it is now possible to apply it not only in scientific research institutes, clinics and hospitals, but also in dispensaries, on railways, in villages and even on board ship. Conserved blood is conveyed by aeroplane, and, should it not be possible for the aeroplane to land, the blood is sent down by parachute. Thus, it has become possible for the operation to be performed in remote parts of the country where there happens to be no clinic or hospital at hand. Blood transfusion assumes special importance in wartime. Statistics show that approximately forty per cent of the wounded that die on the field of battle might be saved by blood transfusion.

Neither professional nor enforced donation of blood is practised in the U.S.S.R. There are always sufficient voluntary donors in this country desirous of giving their blood for those who stand in dire need of it, but this never becomes a profession. Some people have been giving theirs for years. For example, a man named Krushinsky, employed on the construction of the Moscow underground railway, has given his blood for transfusion over a

hundred times, the total amount being about thirty-six litres. Velikanov, a physical-culture instructor, has given his blood to 114 patients in the course of nine years; Nizyaeva—a hospital nurse—has saved the lives of sick and wounded 76 times with her blood. During the fighting on the Finnish front about 60,000 persons applied to Leningrad medical institutions, offering their blood for the needs of the army.

The number of offers made far exceeded the number accepted, of course. It is the rule in the U.S.S.R. that the donor must be perfectly healthy, so that the operation is effected with the maximum of benefit to the recipient and no injury whatever to the donor, who is previously examined by a committee of doctors and specialists. From one to two glasses of blood are usually taken, a quantity that is replaced by the blood-making organs of the healthy body in the course of six to eight days. The operation in no way affects the donor's health, he feels perfectly well and can work as usual. The next portion of blood is taken after a lapse of six weeks and then only if the blood content has been fully replaced.

In addition to the blood of living, healthy donors, transfusions are often made from the blood of those who have met with sudden death or died as the result of an accident. If the dead person has no open wounds on his body and was not suffering from syphilis, malaria or a number of other specified diseases, the blood drawn during the first six hours after decease is biologically perfect and can be used for transfusion. So can the placenta-blood ejected through the umbilical cord after the delivery of a child. This blood is rich in haemoglobin and hormones and in certain cases has a still more beneficial effect than the ordinary blood of donors.

The Central Institute of Haematology and Blood Transfusion is working now on a series of problems that promises to extend still further the field open to blood transfusion. Experiments are being conducted in the transfusion of small doses of blood of incompatible groups and also that of animals, for example, goats. The stimulating influence of the transfusion in these cases is often much more marked.

The problem of dried blood is one of extraordinary interest. G. V. Rosenberg, a young scientist, is working on it at present. He has found a method of drying it completely and then, by dissolving it, obtaining biologically perfect plasma and serum. The dried plasma and serum can be kept for years; consequently, a stock of it can be taken anywhere and used for transfusions whenever necessary. Operations performed on rabbits have proved successful; experiments are now being made on people.

BOOK REVIEW

Introduction to Carbohydrate Biochemistry—by D. J. BELL. University Tutorial Press, London, 1940. Pp. vi+112. Price 3s. 6d.

As Sir F. G. Hopkins says in a foreward to this little book, "in the domain of life that type of molecular structure which we recognise as belonging to carbohydrates plays an outstanding part". The task of throwing light in this "outstanding part" has doubtless been facilitated during the last one or two decades by the very remarkable advances that have been made in our knowledge concerning the molecular structure of the carbohydrates, starting with the classical researches of Emil Fischer. The book, therefore, logically devotes a fair part of the book to the structural aspect, without the knowledge of which proper understanding of the biochemical events concerning these bodies in the living system is not possible.

In the first chapter the fundamental question of photosynthesis is dealt with and it is pointed out that the theory of the intermediate formation of formaldehyde is not yet proved or disproved. In cases claiming to have shown the formation of formaldehyde, it seems to have arisen from causes other than the fixation of carbon. In the second and third chapters the structural chemistry of sugar and polysaccharides are treated. The fourth and fifth chapters are devoted to the subject of alcoholic fermentation and muscle glycolysis and associated phenomena and the sixth chapter deals with the enzymatic breakdown and synthesis of carbohydrates. The uronic acids, glycosides and nucleotides are treated in the next three chapters and an interesting account of micro-organisms in relation to the carbohydrates is given in the last chapter. There are references to recent work at the end of each chapter and a subject index has been appended.

The striking feature of the book is that the whole subject has been sought to be treated in an elementary way while at the same time attempts have been made to include up-to-date information in practically all aspects of carbohydrate biochemistry. This has the merit that much misinformation which would be provided by older literature is automatically excluded. But it would seem that the supply of basic information

and the history of the development of this knowledge have to some extent suffered. The teacher should, for instance, supplement chapters II and III for imparting greater elucidation. As the author says, the book has been written mainly for part I of the natural sciences tripos at Cambridge but the book will be welcomed not only by advanced students but also by research workers for much new useful information in varied fields that has been collected and presented in an admirable perspective.

B. C. G.

Handbook of Common Water and Marsh Plants of India and Burma—by K. BISWAS and C. C. CALDER. Health Bulletin No. 24 (Manager of Publications, Delhi) 1937. Price Rs. 2/12.

The book, as it is mentioned in the authors' preface, is intended for the public health officers in India in connection with the work of the malariological survey of India. An attempt has therefore been made to incorporate as many common water and marsh plants of India and Burma as are related to the life history of mosquitoes. The book deals in brief with the bionomics of freshwater aquatic vegetation, general features of aquatic vegetation, periodicity of water plants, methods of controlling the growth of aquatic plants. In addition to these, descriptions of nearly all the common species of water and marsh plants have been given and profusely illustrated with pen and ink sketches. Information on ecology, distribution, economic uses and other details has been added where required. Keys to the genera and the species have also been provided to guide field botanists and malariologists to identify the plants on the spot. A short glossary of botanic terms appended to the book proves useful to those unacquainted with the technical botanical terms. The total number of species mentioned in the book is 213, of which 157 are Phanerogams, 2 Bryophytes, 15 Ferns and their Allies and 39 Algae. Algal flora plays a very important role in the public health, sanitation and drainage questions of this country. Although, it was not possible to deal in detail with this very important and large portion of

aquatic and marsh flora, sufficient matters for working purpose have been embodied in the sixteen pages from 111 to 127. Most of the species of Algae treated in the book, have also been figured. No publication of this type is known to have appeared so far. The book therefore fulfils a long felt want in the literature on Indian flora—particularly the aquatic plants in which major portion of the sub-continent of India is abundant. The book will also prove to be of much interest to the overseas botanists as well, as many of the water plants are cosmopolitan and are of considerable importance from the standpoint of taxonomy, phytogeography, plant anatomy and evolution of plants.

Flora of Assam, Vol. V—By N. L. BOR. Issued by the Forest Research Institute (Manager of Publications, Delhi).

Volume V of the *Flora of Assam* by Dr N. L. Bor, Forest Botanist, Dehra Dun, deals with the grasses of the province of Assam. 399 species of grasses belonging to 147 genera, including two new genera have been described covering 480 pages. The volume is well printed and nicely bound. The two new genera are—*Eragrostiella* Bor and *Narenga* Bor. Six other genera—*Vulpia*, *Danthoniopsis*, *Oryzopsis*, *Ischilema* and *Sehima* are new records for Assam. The exotic species that have established themselves in the province are as many as 33 belonging to several genera.

Assam stands pre-eminently richer both in genera and species as compared with the grass flora of other provinces of India. The hot and humid hills and valleys of Assam appear to be the congenial home of the *Bambuseae*. 52 species of bamboos out of a total of 75 species for the whole of India have been found growing in Assam. *Panicaceae* and *Andropogoneae* have almost equal number of species. A number of the genera of temperate and colder climates have been recorded. Recent exploration in the Balipara Frontier Tract has added several new records to Assam and as the author presumes, one can expect many more additions when the bordering hills particularly the higher altitudes become better known. *Vulpia myuros* (L.) Gmelin (*Festuca myuros* L.) is one of the new records for Assam, collected from the Balipara Frontier Tract by Capt. Kingdon Ward. This has not been reported till now to the east of Garhwal in the North-West Himalaya. Its occurrence in a country several hundreds of miles to the east of its original home is indeed one of the very interesting examples of disjointed distribution.

The author has rightly adopted the recent systems of classification and nomenclature and the

synonymy given in the book might prove a little puzzling to those unacquainted with the recent changes in the nomenclature of grasses. The work starts with the *Bambuseae*, the tribe accepted by all agrostologists as the most primitive among grasses and ends with the most highly developed group, the *Maydeae*. This arrangement is diametrically opposite to that of Dalton Hooker in the *Flora of British India*, who started with the *Panicaceae* and ended with the *Bambuseae*. Dr Bor has also gone a step further than his giant masters and the other authors of Indian *Gramineae*, in following the splitting up of *Arundinaria* into several smaller groups after the Japanese author Makino.

The genera *Panicum* and *Paspalum* of the *Panicaceae*, *Andropogon* and *Rottboellia* of the *Andropogoneae* of the *Flora of British India* have also been split up into several smaller groups after Otto Stapf. The author has provided keys to the tribes, genera and species, which have been drawn up with a view to their practical utility on the field. The original references to the species followed by the most important synonyms are given in all cases. The omission of references to the *Flora of British India*, which latter work would certainly remain the standard work of reference for a long time to come is regrettable. It is because the arrangement and nomenclature of *Gramineae* in the several Indian herbaria is still that of the *Flora of British India* and as the names of a great many species of the *Flora of British India* have been changed in recent days and have been adopted in this work, omission of references to this standard work is likely to prove a great handicap to Indian workers. The present volume is no exception to it. It is hoped that the author may well be pleased to remove the blemishes that appear here and there in the key and in the corresponding descriptions. Apart from the two new genera mentioned already, the author has made the following new combinations:—

Danthoniopsis Griffithiana (C. Muell) Bor,
Narenga porphyrocoma (Hance) Bor, *Eragrostiella leioptera* (Stapf) Bor, *E. bifaria* (Wt.) Bor,
E. brachyphylla (Stapf) Bor, *E. Walkeri* (Stapf) Bor, *E. Collettii* (Stapf) Bor, *E. nardoides* (Trin.) Bor and *E. secunda* (Nees) Bor.

Very little attention has so far been paid in India to agrostology—an important branch of botany of considerable economic importance. The classification and nomenclature of grasses has undergone remarkable changes and the author by incorporating such changes in his local grass flora of Assam has laid the basis of similar works on modern lines. Dr Bor has thus rendered a great service to the botanical science in India and rightly earns grateful

thanks of Indian systematists. It is indeed gratifying that the publication of the volume on Gramineae (Vol. V, 1940) concludes for the present the series on the *Flora of Assam* started in 1934 by the late Rai Bahadur U. N. Kanjilal of revered memory and subsequently followed by his worthy son Mr P. C. Kanjilal and Messrs. A. Das and R. N. De.

K. B. and V. N.

Plants of the Lloyd Botanic Garden, Darjeeling

—by DR K. BISWAS, M.A., D.Sc. (Edin.), F.R.S.E., Superintendent, Royal Botanic Garden, Calcutta. (Records of the Botanical Survey of India, Vol. V, No. 5). Price Rs. 3/14.

Visitors to Darjeeling, interested in plant growth, will find in an annotated list of plants grown or which it is possible to grow in the Lloyd Botanic Garden at Darjeeling, just brought out by the Botanical Survey of India, a useful guide to help them in naming many of the interesting plants of the locality. The publication is more or less a handbook to the plants in and about Darjeeling.

Situated in a region, rich in botanical specimens, the Lloyd Botanic Garden has nearly 1,500 plants grown in it. The majority of these are of indigenous origin, but there are many foreign species too of the temperate regions of Japan, North America, Australia, China, Malaya, Europe, South America, Tropical Asia, Central America, Burma and Africa, which were introduced in the past, but have since got acclimatised and spread beyond the boundary of the Garden.

The history of the Lloyd Botanic Garden, Darjeeling, can be traced as far back as 1865 when the need for a branch establishment in the Himalayas of the Royal Botanic Garden, Calcutta, was realised and Dr T. Anderson started such a garden as well as the Cinchona Nursery at Rungyroom at a distance of six miles from the town of Darjeeling. The then Governor of Bengal, Sir Ashley Eden, decided to develop the garden near the station of Darjeeling. In 1898 Mr William Lloyd made over to Government a beautiful plot of land which was laid out into a botanic garden under the guidance of late Sir G. King, the then superintendent of the Royal Botanic Garden, Calcutta. The garden, together with a local herbarium, gradually developed in the hands of successive superintendents and curators into a regional garden with an upper indigenous section, a lower exotic section and a miscellaneous section. A rock garden, now named the Sir John Anderson Rock Garden, near about the centre, was also built for growing rare and delicate Alpine Himalayan species of great beauty and importance.

A Revision of the Labiatae of the Indian Empire—By DR S. K. MUKERJEE. (Records of the Botanical Survey of India, Vol. XIV, No. 1, 1940).

This book, which has recently been published, has brought together into one compass, all our scattered knowledge of the family in India and Burma, that had been accumulating since an account of it was first published by Sir J. D. Hooker, in Volume IV of the *Flora of British India* in 1885. Such a knowledge of Indian plants, and in particular of the Indian Labiatae, both known as well as unknown is to be found only in a number of publications and in the collections stored in the several herbaria in India and abroad, especially Great Britain. The revision of the *Flora of British India* is indeed a long felt need. Dr Mukerjee's work, which is based on a personal examination of the collections of the family in the herbaria of Sihpur (India), Kew (London) and Edinburgh (Scotland) is very opportune and a welcome contribution to the study of the systematic botany of India and Burma.

This work appears to have been executed with much care and pain and consists of an introduction, bibliography, descriptions of the family, genera and species, keys to the tribes, genera and species under each genus, with an index at the end. In the introduction the author has discussed in general the distribution of the genera and the species in India and Burma and the relationship such distribution bears to the labiates in countries bordering on India on the landward side and countries elsewhere in the world.

The Labiatae, being mainly a family of temperate climate, has its largest distribution on the Himalayas and on the summits of the higher hills in other parts of India and Burma. It is poorly represented on the plains. The author has described 425 species belonging to 69 genera as against 286 species belonging to 56 genera described in the *Flora of British India*. There has thus been an increase of nearly 50 per cent in the total number species during the last 56 years. Nearly 50·3 per cent of the species is estimated to be endemic in India and it is interesting to know that the largest number of endemic species occur in the peninsular India, south of the Vindhyas. It is also stated that of the 208 species that are reported to occur on the Himalayas, more than half has been found to be confined to the north west, 51 to the east and 51 to both east and west. It is inferrable from this peculiar predominance of the Labiatae in the north west that the Labiatae finds a more congenial home in the bleak north west than in the humid N. E. Himalayas. Genera of great economic importance like *Perilla*, *Mentha*,

Thumus, Origanum, Melissa, etc., appear to be confined to the Himalayan region.

The keys to the tribes, genera and the species appear to have been drawn up briefly, but carefully with the view of practical utility to the field botanist in mind. The copious reference to literature relating to genera, below each genus is indeed a happy departure from the usual type of such floristic works in the past. Such references are not generally given even in a number of similar revisions that have appeared recently. The author has also included all the important references for the species, especially the Indian publications, which is indeed a great help to the future worker.

The following new species which the author published in the *Notes of the Royal Botanic Garden, Edinburgh*, recently, has been included:—

Acrocephalus palniensis, *A. verbanæifolius* Watt ex Mukerjee, *Dysophylla khasiensis*, *Gomphostemma Lacei*, *Phlomis burmanica*, *Phlomis Younghusbandii*, *Salvia Lacei*, *Teucrium burmanicum* and *T. shanicum*.

He has also described a new species here, namely *Teucrium Anandalei*. *Nosema grandiflora* (Doan) Mukerjee is a new combination proposed by the author.

Nosema Prain, *Ceratanthus* Mueller ex Taylor, *Zataria* Boiss. *Satureia* L., *Ziziphora* L., *Chamaecphacos* Schrenk. *Mollucella* Bth. *Lagochilus* Bunge, *Microtaena* Prain, *Paralamium* Dunn, *Paraphlomis* Prain, *Rubiteucris* Kudo and *Eurysolen* Prain are additional genera not mentioned in the *Flora of British India*. But their representative species occur only on the frontiers of India, the first eight hailing from the north-west and the second five from the north-east.

The nomenclature of the genera and the species has been thoroughly revised and brought up-to-date. In this connection, the author appears to have taken the fullest advantage of the opportunities and facilities he had during his stay in Great Britain, where he prepared this work. The author has carried out this work to the best of his ability and has thereby rendered a great service to the advancement of the knowledge of systematic botany of India.

K. B. and V. N.

Anthropological Papers. New Series, No. 5. Published by the University of Calcutta, 1938. Pp. 112, plates. 12.

It is a collection of seven short articles written by six authors. In the "Anthropological Notes on some Assam Castes" Dr B. N. Dutt gives a comparative anthropometric study of nineteen different castes of Assam. The number of subjects varies from 18

to 1 in the different castes—seven having one each and four, two each. The total number of persons dealt with is 95. The author concludes that the group is not homogeneous and "that there are common elements present in all the groups". He further adds that these people are not ethnically isolated from the rest of Northern India. Dr Dutt's conclusions are rather based on scanty data as he himself acknowledges. We are afraid that the biometricians will not feel happy to see their methods applied or rather misapplied consciously in this manner.

Mr J. C. Ghosh in his "Hindu Anthropology" tries to prove from ancient records that the "Hindus had their Anthropometry and Ethnology from a very early period". This is more patriotic than scientific. Mr S. Sircar ascribes the origin of totem concept to primordial man's realisation of inferiority to animals and plants in meeting biological needs and consequent adoption of one or other of these groups for protection against hunger and other unforeseen dangers. One of the obvious objections to it is the sporadic occurrence of totemism instead of its universal distribution which is expected from such a theory. Plants and animals grow vigorously in places where man is found and even where they do not occur but why not totemism in all such regions. In "Juristic Ethnology of the Meithei and the Nagas" Mr S. Singh tries to show the relation between the socio-political constitution of the Meithei and their legal doctrines and compares the whole with the same phenomena among the Nagas. Mr S. K. Bose describes a large number of stone beads of different sizes and shapes found at Sabour in his "Saboulean Beads and Bangles". Mr D. Sen carries us to the palaeolithic times in his account of 33 stone implements collected by Mr K. K. Sen Gupta from the Upper Siwaliks near Simla. According to him the implements exhibit mousterian character and some of them "have a technique very strikingly similar to the technique found in the lithic industry recently obtained in Sjari-Osso-Gol and Choei-Tong-Keou in China". The volume is brought to an end by a short but very neat account of the Nulias of Puri by Mr D. Sen. The anthropometric analysis of the people based on 150 individuals, shows them to be a long-headed, fine-nosed, medium to short statured group with plentiful black, wavy hair and brownish dark skin. The Nulias live in small villages along the sea coast and depend on fishing in the sea for their livelihood. The author describes their marriage system, divorce, caste-organisation, and religion.

The plates are on the whole good and the papers cover a wide field of investigation. The articles are interesting and record useful information.

T. C. B.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters]

A Source of Berberine Salts from "Rasot" Roots (*Berberis Aristata*)

During the investigation of an unidentified alkaloid which is present in very small amounts in "Rasot" roots, we have followed a method by which it is possible to isolate berberine in the form of its salts without any difficulty.

Coarsely powdered "Rasot" roots were repeatedly extracted with boiling 2 per cent. hydrochloric acid solution and the combined acid extract concentrated on the water-bath. The resinous impurities precipitating out were filtered off and the filtrate diluted to twice its volume with 5 per cent. solution of sodium chloride. The whole was then heated at 60° — 70° for 10 minutes and filtered to remove any resinous material that separated out.

The filtrate, on keeping overnight in a cool place, deposited crystals of berberine hydrochloride; a further crop of crystals was obtained on addition of a small amount of solid sodium chloride to the mother-liquor. The yield was found to be 2.23 per cent. on the weight of roots extracted.

For making berberine sulphate, extraction was done with 0.5 per cent. sulphuric acid and the acid decoction concentrated to a syrupy mass; which was filtered after diluting to twice its volume with 5 per cent. solution of sodium sulphate. The filtrate was concentrated to its original volume and after filtration allowed to stand for 12 hours in a cool place, when berberine sulphate crystallised out as slender yellow needles. A further crop of crystals was obtained on addition of solid sodium sulphate, to the mother-liquor. Yield 3 per cent.

Basification of mother-liquors, after removal of berberine salts, with ammonia and subsequent extraction with ether furnished a small amount of an alkaloid, the oxalate of which crystallised from

50:50 mixture of alcohol and acetone in groups of colourless needles m.p. 222° — 224° (decomp.).

Further work on this alkaloid is in progress.

J. N. Ray

B. S. Roy

University Chemical Laboratories, Lahore,
and

Office of D. G., I.M.S.,
New Delhi, 4-3-1941.

Vanadium, Chromium and Molybdenum in Indian Coals

Indian coal ashes have been analysed by various workers and the percentage of common constituents such as SiO_2 , Al_2O_3 , Fe_2O_3 , TiO_2 , P_2O_5 , SO_2 , CaO , MgO , K_2O , Na_2O have been noted.¹ So far as we know, no work has been done on their rare constituents. In this laboratory ashes of some Indian coal from Jharia field, Salt Range etc. have been analysed and they have all been found to contain small quantities of vanadium, chromium and molybdenum. The vanadium content was estimated colorimetrically as phosphotungstovanadic acid by the method of E. B. Sandell² and the order of the quantity present (as V_2O_5) was about $n \times 10^{-3}$ per cent. of the coal ash or $n \times 10^{-3}$ per cent. of coal. The chromium was estimated colorimetrically by the diphenyl carbazide method of Cazeneuve and the quantity present was found of the same order as that of vanadium. Molybdenum was also found to occur in coal ashes but in much smaller quantities. The order of the quantity present was about $n \times 10^{-3}$ per cent. of coal ash or $n \times 10^{-4}$ per cent. of coal. Spectrographic analysis of the ashes are in progress. Details of the analysis will be published elsewhere.

I express my thanks to Dr P. B. Sarkar for his helpful guidance.

Jyotirmoy Das Gupta

Department of Chemistry,
University College of Science,
Calcutta, 7-3-1941.

¹ Dutta Roy, *Proc. Nat. Inst. Sc. Ind.*, 6, 539, 1941.

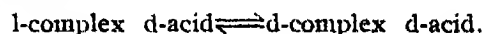
² *Ind. Eng. Chem.*, Annual Edition, Vol. 8, p. 336, 1936.

Resolution of Cobaltic Trisbiguanide Complex into Its Optically Active Enantiomerides

IN connection with our work¹ on cobaltic trisbiguanidine and its salts, which have been found to be *inner-metallic complexes* of the *second order* of a special type and to contain three symmetrical bifunctional biguanide radicles—co-ordinated with the central cobalt atom in an unsymmetrical manner—giving rise to a structure with no plane or centre of symmetry like trisethylenediamine cobaltic salts, we have observed an anomaly while experimenting on the resolution of cobaltic trisbiguanidinium chloride into its optically active enantiomorphous isomerides.

The resolution of the complex chloride, $[\text{Co}(\text{C}_2\text{N}_3\text{H}_7^+)_3]\text{Cl}_3$, was effected by combining it with either d-tartaric or d-camphorsulphonic acid. The diastereoisomerides, chloro-d-tartrate, d-tartrate and d-camphorsulphonate of the laevo- and dextro-cobaltic trisbiguanide base, have been prepared in the pure state, the l-salt in all cases being less soluble. But a solution of the chloro-d-tartrate of the racemoid complex base deposited crystals of only the laevogyrate on fractional crystallization in the cold, till the entire solution was dried up. An observation, possibly for the first time in the case of complex inorganic salts, is thus made of what may be regarded as an "*asymmetric transformation of the second order*" as described by Kuhn². Further evidence on the point is furnished by the study of the "*addition curve*", according to Jamison and Turner³, obtained by the gradual addition of the racemoid base to a solution of d-tartaric acid. The mother liquor, after the separation of the first crop of laevogyrate from a solution of the chloro-d-tartrate of the racemoid complex, was found, however, to be slightly dextro-rotatory. From this, pure dextrogyrate was obtained by repeated fractional precipitation with alcohol. A change in the external condition by changing the nature of the solvent rendered possible the isolation of the pure d-salt. A freshly prepared dilute solution of the chloro-d-tartrate of the racemoid complex is slightly dextro-rotatory, $[\alpha]_D^{25} = +6^\circ$ (1% sol.),

and this dextro-rotation was found to increase gradually with time to a constant maximum value. The same rotation value was also arrived at, starting from a solution of the chloro-d-tartrate of the laevo-rotary as well as of the dextro-rotary complex. Thus approaching from three different directions the same rotation value $[\alpha]_D^{25} = +14^\circ$ was obtained, using a one per cent. solution in all cases. All these facts clearly indicate that in a solution of the chloro-d-tartrate of the racemoid complex there is an equilibrium between the two mutually inter-convertible dextro- and the laevo-salt with the former in slight excess, and that the rate of their interconversion is rather slow:—



Calculated from the equilibrium rotation value, the initial rotation of the partial racemate and the rotation value of the pure d-salt, $[\alpha]_D^{25} = +340^\circ$, the equilibrium composition corresponds to 51.2% d-salt and 48.8% l-salt in solution, from which the equilibrium constant $K_{48} = 1.049$. The laevo-salt, being much less soluble in water, separates out, however, from a *saturated* solution of the chloro-d-tartrate of the racemoid base before the kinetic equilibrium can be established; the solution, therefore, deposits only the laevo-salt on gradual crystallization, though the dextro-salt is the more stable of the two. There is thus a continuous transformation from the dextro- to the less soluble laevo-variety in this solution:—
Solution (dextro) \rightleftharpoons Solution (laevo) \rightarrow solid (laevo).

A solution of the d-tartrate of the racemoid complex, in spite of its being characterised by asymmetric transformation, can, however, be normally fractionated giving the pure laevo- and dextro-gyrates as the least and the most soluble fractions respectively, due to favourable solubility and stability relationships.

From the pure laevo- and the dextro-salt of the chloro-d-tartrate of the complex base, pure laevo- and dextro-modifications of the cobaltic trisbiguanidinium sulphate, chloride and nitrate have been prepared. The molecular rotations of these latter are quite high, much higher than those of the corresponding trisethylenediamine salts, as might be expected from their constitution with a lower order of symmetry, suggested by Ray and Saha⁴.

The complete paper with experimental details will be published elsewhere.

N. K. Dutt
P. Ray

Inorganic Chemistry Laboratory,
University College of Science,
Calcutta, 7-3-1941.

¹ Ray and Dutt, *Jour. Ind. Chem. Soc.*, 16, 52, 1939.

² Kuhn, *Ber.*, 65, 40, 1932.

³ Jamison and Turner, *Jour. Chem. Soc.*, 1940, 1938.

⁴ Ray and Saha, *Jour. Ind. Chem. Soc.*, 16, 679, 1939.

Cleaning of Copper, Bronze and Brass Specimens in Museum

Copper specimens generally contain a certain proportion of one or more of the following metals, viz., silver, lead, arsenic etc. The latter increases the natural power of copper to withstand corrosion. Burial in soil containing salts and limestone exposes the metal to corrosion. Action of moisture and of air and carbonic acid always play an active part in determining the nature of corrosion of the metal.

When a copper or bronze specimen is so much corroded that no free metal remains, there is no necessity for washing it under hot water. For cleaning copper, bronze and brass specimens and removing the incrustations deposited on them, a solution of ammonium chloride (NH_4Cl), stannous chloride (SnCl_2) and dilute hydrochloric acid (HCl) has been used with much success in the Asutosh Museum Laboratory, Calcutta University. The proportion of the solution used is:—

10 gms. of NH_4Cl and 10 gms. of SnCl_2 in 30 c.c. of dilute HCl .

A large number of copper, bronze and brass specimens were treated by the writer. Each specimen was carefully brushed under hot water for several times. Then it was left on a paper-made tray for two days in a cool dry place for drying. At the end of this period the solution given above was applied. Good results were obtained in all cases. The specimens are now under observation for the last seven months, from July, 1940 to February 1941, and have not shown any further sign of corrosion.

A particular copper specimen was partially treated in the above method and later on rubbed with the leaves of *Oxalis corniculata** occasionally at an interval of 2 or 3 days. This has also given good result. It has also withstood corrosion for the last seven months.

Ashutosh Museum Laboratory,
Calcutta University, Minendra Nath Basu
Calcutta, 26-2-1941.

Effect of the Cabinet Material on the Performance of a Radio Receiver

It is well known that the performance of a receiver is affected to a great extent by the cabinet material. Unfortunately, however, no data are

available to give the effect of cabinet material and shape on the reproduction. In order to determine the probability of the influence of the cabinet, a statistical study was made of the different types of wood and bakelite cabinets of the same size and shape on the performance of a standard radio receiver. The data obtained were then utilised to derive information about the effect of these materials on the performance.

The present note contains the results of the study of the above relations. The audio side of a standard Marconi Communication type RS 5 F was fed by the Beat Frequency Oscillator giving audio note from 0 to 12 kilocycles of different strengths. This receiver was selected because of its resistance-capacity coupling in the L/F stage and thus the frequency response was uniform. Sound effects were picked up by a ribbon microphone assembly which fed through low impedance lines to an amplifier. This amplifier was also of the resistance-capacity coupling to improve the frequency response. The output of this amplifier was connected to an oscillograph as well as to a vacuum tube voltmeter.

Various types of wood, such as sandal-wood, oak, pine, shisham, Burma teak, deodar, were experimented upon. It has been found from continuously fifty tests on each type of wood that wooden cabinets improve the apparent signal to noise ratio as higher frequencies are absorbed more than the lower ones. This effect is more pronounced if the wood is of the plywood type than if it is of ordinary timber.

The bakelite cabinets do not absorb higher frequencies and thus the note in these is generally shriller. These results show that from the cost, shape and performance point of view, wooden cabinets, specially plywood ones, are better than the bakelite type.

R. D. Joshi.

Sir Cusrow Wadia Institute
of Electrical Technology,
Poona, 26-2-1941.

Bi-variate Correlation Surfaces

The problem of generating bi-variate correlation surfaces $f(x, y)$ has been of long standing. W. F. Kibble¹ has in a recent paper discussed the case when X , the marginal distribution of x , follows Pearson's Type III law, while Y , the marginal distribution of y , follows the normal or the Type III law. In this paper I have developed corresponding cases for the whole of Pearsonian system of univariate frequency curves, as well as for certain Basal

* A kind of acid plant known in Bengali as *Amrul* (David Prain—*Bengal Plants*—Vol. I, p. 294).

function populations. Various combinations of these forms have also been considered. The regression curves, homoscedasticity, and the approximating forms of these surfaces are under consideration. Some of the results are mentioned below :

(1) X and Y both follow the Type I law :—

$$f(x,y) = \text{Const. } (xy)^p \{(1-x)(1-y)\}^q \\ F_4 \{p+q+2, p+q+2; p+1, q+1; \rho^2 xy, \rho^2(1-x)(1-y)\}$$

(2) X follows Type I law, Y follows Type III law :—

$$f(x,y) = \text{Const. } \exp\left(-\frac{y}{1-\rho^2}\right) \frac{(xy)^p (1-x)^q}{\{1-\rho^2(1-x)\}^{p+q+2}} \\ \times {}_1F_1\left\{p+q+2; p+1; \frac{\rho^2}{1-\rho^2} \cdot \frac{xy}{1-\rho^2(1-x)}\right\}$$

(3) X and Y both follow Type VI law :—

$$f(x,y) = \text{Const. } (xy)^p \{(1+x)(1+y)\}^{-q-p-2} \\ \times F_4\left\{p+q+2, p+q+2; p+1, q+1; \frac{\rho^2 xy}{(1+x)(1+y)}, \frac{\rho^2}{(1+x)(1+y)}\right\}$$

(4) X follows Type III law, Y follows Type VI law :—

$$f(x,y) = \text{Const. } \frac{\exp\left(-\frac{x}{1-\rho^2}\right) (xy)^p}{(1-\rho^2+y)^{p+q+2}} \\ F_1\left(p+q+2; p+1; \frac{\rho^2}{1-\rho^2} \cdot \frac{xy}{1-\rho^2+y}\right).$$

(5) X follows the normal law, Y Student's law :—

$$f(x,y) = \text{Const. } \frac{\exp\left(-\frac{x^2}{2(1-\rho^2)}\right)}{\left\{1 + \frac{y^2}{1-\rho^2}\right\}^{\frac{n}{2}}} \sum_{p=0}^{\infty} \frac{\left(\frac{n+p}{2}\right)}{p!} \\ \left\{ \frac{4\rho^2 x^2 y^2}{1 + \frac{y^2}{1-\rho^2}} \right\}^{\frac{p}{2}}.$$

(6) X follows Type III law, Y Student's law :—

$$f(x,y) = \text{Const. } \frac{\exp\left(-\frac{x}{1-\rho^2}\right) x^{\frac{n-3}{2}}}{\left\{1 + (1-\rho^2)y^2\right\}^{\frac{n}{2}}} F_1\left\{\frac{n}{2}; \frac{n-1}{2}; \frac{\rho^2}{1-\rho^2} \cdot \frac{n}{1 + (1-\rho^2)y^2}\right\}.$$

(7) X and Y both follow Student's law :—

$$f(x,y) = \text{Const. } \{(1+x^2)(1+y^2)\}^{-\frac{n}{2}} \\ \sum_{p=0}^{\infty} \frac{\left\{ \Gamma\left(\frac{n+p}{2}\right) \right\}^2}{p!} \left\{ \frac{4\rho^2 x^2 y^2}{(1+x^2)(1+y^2)} \right\}^{\frac{p}{2}} \\ \times {}_2F_1\left\{\frac{n+p}{2}, \frac{n+p}{2}; \frac{n-1}{2}; \rho^2 \{(1+x^2)(1+y^2)\}^{-1}\right\}.$$

(8) X and Y both follow D²-law (classical) :—

$$f(x,y) = \text{Const. } \exp\left\{-\frac{x+y}{1-\rho^2}\right\} \cdot I_m(2q\sqrt{x}) \\ I_m(2q'\sqrt{y}) \cdot I_m\left(\frac{2\rho}{1-\rho^2} \sqrt{xy}\right).$$

(9) X and Y both follow McKay's law :—

$$f(x,y) = \text{Const. } \exp\left\{-\frac{x+y}{1-\rho^2}\right\} \cdot (xy)^{\frac{m}{2}} \\ I_m\left(\frac{x}{c}\right) I_m\left(\frac{y}{d}\right) I_m\left(\frac{2\rho}{1-\rho^2} \sqrt{xy}\right).$$

It will be found that where both X and Y follow the same law, the parameters involved are the same. The general case of different parameters for X and Y is under investigation.

Statistical Laboratory,

Presidency College,

Calcutta, 3-3-1941.

M. P. Shrivastava

¹ W. F. Kibble, *Sankhyā*, Vol. 5, part 2, 1941.

Proton-Proton Scattering and Yukawa Particle

In a recent paper¹ I have developed the wave-statistical theory of Proton-Proton Scattering taking the interaction potential in the form $Ae^{-\alpha r}$. The agreement of the theory with the experiment of Tuve, Heydenburg and Hafstad² was fairly good.

I have now derived a rigorous formula of the Scattering using Yukawa interaction potential, viz.,

$$\frac{A}{r} e^{-\alpha r}$$

for the short range force between the protons. I find

for the departure (D) of the intensity of Scattering from the value given by Mott-formula—

$$D = \frac{\text{cosec}^4 \theta \cos^2 k'r_0' + \sec^4 \theta \cos^2 k''r_0'' - \text{cosec}^2 \theta \sec^2 \theta \cos k'r_0' \cos k''r_0'' - 2 \frac{Mv^2}{e^2} \left\{ (g_1 f_1 - \frac{1}{2} g_2 f_2) \cdot \text{cosec}^2 \theta \cos k'r_0' + (g_1 f_2 - \frac{1}{2} g_2 f_1) \sec^2 \theta \cos k''r_0'' \right\} + \left(\frac{Mv^2}{e^2} \right)^2 \left\{ g_1^2 f_1^2 + g_2^2 f_2^2 - g_1 g_2 f_1 f_2 \right\}}{\text{cosec}^4 \theta + \sec^4 \theta - \text{cosec}^2 \theta \sec^2 \theta}$$

where

$$g_1 = \frac{4\pi^2 MA}{h^2} \cdot \frac{e^{-\alpha r_0'}}{\alpha^2 + k'^2}, \quad g_2 = \frac{4\pi^2 MA}{h^2} \cdot \frac{e^{-\alpha r_0''}}{\alpha^2 + k''^2}$$

$$f_1 = \cos k'r_0' + \frac{\alpha}{k'} \sin k'r_0',$$

$$f_2 = \cos k''r_0'' + \frac{\alpha}{k''} \sin k''r_0''$$

$$k' = \frac{2\pi Mv}{h} \sin \theta, \quad k'' = \frac{2\pi Mv}{h} \cos \theta$$

and the critical approaches r_0' and r_0'' without and with exchange are given by the equations

$$r_0' = 2.7 \times \frac{e^2}{Mv^2} (\text{cosec} \theta + 1) + 2.7 (\sin \theta - \sin^2 \theta) g_1$$

$$r_0'' = 2.7 \times \frac{e^2}{Mv^2} (\sec \theta + 1) + 2.7 (\cos \theta - \cos^2 \theta) g_2$$

Apart from the fact that there is almost exact agreement of the above formula with second and more reliable experiment of Tuve and others³, it is possible to calculate definitely the values of A and α in Yukawa potential. Thus for incident velocities 867 K.V., 776 K.V., and 670 K.V. used in the above

experiment, I find approximately $\frac{A^{1/2}}{e} = 6$ and $\frac{1}{\alpha}$

$= 3.5 \times 10^{-13}$. The details of these calculations will appear elsewhere shortly. It may, however, be noted that the proposed formula is highly sensitive

to small changes in the value of $\frac{A^{1/2}}{e}$.

It is evident that $A^{1/2}$ has the dimension of ordinary charge. Consequently $\pm 6e$ is the charge of the Yukawa particles inside the protons, giving rise to the short range force. According to Heitler⁴ this charge as calculated from the mass defect of deuteron lies between 5e and 7e, while $\frac{1}{\alpha} \sim 3 \times 10^{-13}$. Thus the present method of calculating the Yukawa charge is more reliable and accurate. The method may be extended to find the Yukawa charge in more complex

particles. Investigation in this direction is still in progress.

Finally I may remark that as the force between neutron-proton and proton-proton is attractive, the sign of the charges must be opposite in these cases. This strongly suggests that the charges are temporarily developed through polarisation, during the process of scattering, specially when the particles are at small distances apart. For if these short range $\pm 6e$ charges permanently existed within the protons or neutrons, it would have been certainly possible to observe cases of short range repulsion between neutron-proton or proton-proton.

Physical Laboratory
Presidency College,
Calcutta, 7-3-1941.

K. C. Kar.

¹ Phil. Mag., 29, 200, 1940.

² Phy. Rev., 50, 806, 1936.

³ Phy. Rev., 56, 1078, 1939.

⁴ Report in Progress of Physics, Vol. 5, 1937.

Specific Heat of some Indian Oils

Already a number of physical properties of Indian oils have been studied by Bhattacharyya¹ from the point of view of viscosity and dielectric constant.

This year some of the results about electric properties (D.C. conductivity of Indian Vegetable Oils) have been published by C. S. Ghosh and S. Chakravarty.² I have studied the specific heat of a number of Indian oils by using the method of cooling. The results are given below.

TABLE I

OIL			SPECIFIC HEAT
1. Coconut	...	...	0.6198 Calori
2. Linseed	...	...	0.6099 "
3. Olive	...	...	0.6027 "
4. Poppy	...	...	0.5819 "
5. Sesame	...	...	0.6676 "
6. Neem	...	...	0.6043 "
7. Sarson	...	...	0.7244 "
8. Andi	...	...	0.7082 "
9. Duan	...	...	0.6436 "
10. Laha	...	...	0.5896 "
11. Maulsiri	...	...	0.6814 "
12. Dhannia	...	...	0.6676 "

TABLE II.
SPECIFIC GRAVITY DATA.

Oil.	Lewkowitsch.		Int. Crit. Tables.		Jamieson.		G. N. Bhattacharyya.		Author.	
	Sp. Gr.	T°C	Sp. Gr.	T°C	Sp. Gr.	T°C	Sp. Gr.	T°C	Sp. Gr.	T°C
1. Coconut ...	0.9100	87.8	0.9260	15.0	0.9150	30.0	0.9149	37.8	0.9085	82.5
2. Linseed ...	0.9342	15.0	0.9300	15.0	0.9270	20.0	0.9287	22.2	0.9097	16.3
3. Olive ...	0.9155	15.5	0.9150	15.0	0.9150	25.0	0.9128	22.2	0.9122	16.5
4. Poppy ...	0.9255	15.5	...	...	0.9240	15.0	0.9301	22.2	0.9142	16.3
5. Sesame ...	0.9170	20.0	0.9190	25.0	0.9200	15.0	0.9187	22.2	0.9196	16.8
6. Neem ...	...	...	0.925	15.0	...	...	0.9151	31.0	0.9254	15.1
7. Sarson ...	...	...	...	...	...	...	...	...	0.9168	15.5
8. Andi ...	...	...	...	...	...	...	...	...	0.9502	16.5
9. Duan ...	...	...	...	...	...	...	...	...	0.9194	15.2
10. Laha ...	...	...	...	...	...	...	...	...	0.9181	16.7
11. Maulsiri ...	...	...	...	...	...	...	...	...	0.9175	16.0
12. Dhannia ...	...	...	...	...	...	...	...	...	0.9122	16.5

TABLE III.
REFRACTIVE INDEX DATA.

Oil.	Lewkowitsch.		Int. Crit. Tables.		Jamieson.		G. N. Bhattacharyya.		Author.	
	Rfr. Ind.	T°C	Rfr. Ind.	T°C	Rfr. Ind.	T°C	Rfr. Ind.	T°C	Rfr. Ind.	T°C
1. Coconut ...	1.4410	60.0	1.4530	25.0	1.4560	25.0	1.4540	28.4	1.4555	16.0
2. Linseed ...	1.4800	20.0	1.4807	25.0	1.4786	25.0	1.4790	28.0	1.4781	17.2
3. Olive ...	1.4698	15.0	1.4667	25.0	1.4680	25.0	1.4672	27.8	1.4689	16.8
4. Poppy ...	1.4751	20.0	1.4742	25.0	1.4751	20.0	1.4742	28.6	1.4700	17.8
5. Sesame ...	1.4728	20.0	1.4704	25.0	1.4698	25.0	1.4713	27.8	1.4700	17.8
6. Neem ...	...	...	1.4607	40.0	1.4621	40.0	1.4650	38.0	1.4681	17.0
7. Sarson ...	...	...	...	...	...	...	...	...	1.4718	16.8
8. Andi ...	...	...	...	...	...	...	...	...	1.4750	16.0
9. Duan ...	...	...	...	...	...	...	...	...	1.4720	16.9
10. Laha ...	...	...	...	...	...	...	...	...	1.4728	17.1
11. Maulsiri ...	...	...	...	...	...	...	...	...	1.4700	17.8
12. Dhannia ...	...	...	...	...	...	...	...	...	1.4700	17.8

To obtain comparable results with other investigators it was thought of interest to secure data for the specific gravity and refractive indices of the oils used in the present investigation. These data refer to the room temperature. The refractive indices were determined with an Abbe direct reading refractometer. The instrument was standardised with Methylum Salicylicum and Zimtol. The densities were ascertained with a delicate hydrostatic balance.

Table II contains the data on densities and table III those on refractive indices. For comparison,

available data of other investigators have also been included.

Ghulam Farid

Physical Laboratories,
Aligarh Muslim University,
Aligarh, 13-2-41.

¹ G. N. Bhattacharyya, *Ind. Jour. Phy.*, 10, 209, 281, 403, 1935.

² C. S. Ghosh and S. Chakravarty, *Proceedings of the 28th Indian Science Congress, Part III*, page 33, 1941.

Physics

The Role of Applied Physics in Industry

P. N. GHOSH

THERE has been a very interesting trend in applied physics by which great branches of its specialised interests have been appropriated by special groups of applied physicists who call themselves engineers as soon as a systematic method for the application of its principles has been developed in special fields. Professor Ghosh explained the position of the applied physicists with reference to its role in industries, first, for those industries which are based more upon ancient art which has been developed largely by practical experiences. The second category embraced those industries which have been built upon recent scientific discoveries, *e.g.*, communications, air transportation, motion pictures with sound and colour accompaniments, illumination and generation and diverse applications of the electric power. The third category included those groups whose activities rest on the basis of other sciences such as, chemistry, biology, etc. Here one finds the chemical industries, the industry of drugs and medicine which though not directly derived from physics but to which physics is contributing an ever-increasing assistance through tools and measuring instruments, methods and interpretative concepts. For the field of medicine, the X-ray has been marvellously developed for diagnostic examination and for therapeutic treatment of certain glandular disorders and growths, notably cancer.

Professor Ghosh dealt first with building and metal industries which represent the class having age-old traditions behind them. Next he took electrical power industry which has been effective in revolutionising all modern industries, then refrigeration industry, which is the direct outcome of laboratory investigations. From the modern industries he chose automobile and aeronautic industries, the last being the youngest of the lot and still in the adult state requiring constant help from researches in applied physics.

BUILDING INDUSTRY

Here one finds that all our structures built to date, rest on earth and a fairly large part of the

world's construction cost is in working the earth; yet through the centuries the very bottoms of our buildings have been designed on an empirical basis. The first International Conference on Soil Mechanics and Foundation Engineering held at Harvard University in the summer of 1937 has disclosed a wealth of outlook and previous lack of understanding of some of the essential aspects of the subject. For the most part the formulae used for estimating the behaviour of soils have involved such drastic assumption as seriously to impair their validity for anything like general application. The analytical approaches to soil mechanics suggested by Petterson, Terzaghi, Jurgenson and others appear to be far more promising than any of the old methods they supersede. The so-called bearing values of the major soil types embodying an accumulation of practical experience, obviously took no account of numerical factors influential in particular set of conditions and were uncertain to a degree and often demanded uneconomical factors of safety and expensive procedures of foundation design.

The applications of these ideas have been tested in some of the structures designed and constructed within the last two years and it has been found to be very satisfactory.

METAL INDUSTRY

Historically, it is more than a probability that the first metal industry was entirely one of applied physics. If as many archaeologists and historians believe, gold was man's first industrial metal, it was recognised by its colour, and its high specific gravity was used as a basis for its separation from the lighter rock-materials. The "panning" operation is pre-historic in origin. It is however used prolifically even today, not only in the prospecting for gold but also for many other heavy minerals. The operation is indeed based on the application of Stoke's law. In the "ore flotation" process, there is the application involving surface tension and adhesive phenomena.

Geology

Palaeogeographical Revolutions in the Indo-Burmese Region and Neighbouring Lands

M. R. SAHNI

In his presidential address Dr M. R. Sahni gave a short account of palaeogeographical history of the Asiatic continent from Vindhyan to Devonian times.

During the Vindhyan period according to Dr Sahni a marine sea extended from the present Vindhyan mountains to as far as Behar. This marine sea has been named as the South Vindhyan sea. According to him a series of more or less connected marine basins existed from Afghanistan or even from Iran along the Himalayan region, Assam, Burma and parts of China.

The similarity in lithological characters between the Vindhyan beds and the Cambrian strata of Iran and Salt Range has been pointed out by Dr Sahni and this similarity in lithology according to him indicates only arid conditions of deposition in these areas throughout both the periods and he concludes that the Vindhyan strata predate the Cambrians and the two cannot be correlated. The definite evidence that could be gathered regarding life during the Vindhyan period was the genus *Fermoria* chapman.

The discovery of Upper, Middle and Lower Cambrian strata in Iran has shown that the vast Cambrian sea extended from America via China, Burma and the Himalayan region, Salt Range to Iran and perhaps to the Dead Sea. Though the Asiatic Cambrian sea and the European Cambrian sea remained almost separate and distinct there are indications of intermingling of these two seas only to a very slight extent. Such intermingling is shown by isolated trilobite species of the Dead sea region showing affinity with British forms. It may be of interest to point out that the Iranian Cambrian fauna is allied more to the far Indo-Chinese rather than to the Salt Range or Central Himalayan faunas, and Dr Sahni suggests that they probably indicate distinct horizons within the Cambrian sequence.

According to the available evidence, the sea retreated from the whole of Western Asia during

Ordovician times. Traces of Ordovician graptolites appear however to have been discovered, but there seems to be no definite record. One of the most important and intriguing problems of the Ordovician of Southern Asia is the anomalous position of the Himalayan and Burmese Ordovician faunas. Considerable emphasis is invariably laid on the fact that while the Burmese faunas are more closely allied to those of Europe, the Himalayan forms show American affinities. The composition of the two faunas is also entirely different. In the intervening region between America and the Himalayas, that is, in China and Burma there is hardly any record of American types of Ordovician fossils. The vexed problems as to how these American fauna reached the Himalayan region puzzle the scientists and have given sufficient food for speculation and suggestions. These are some of the problems that are discussed in the presidential address and it appears that more intensive work would be necessary to give satisfactory explanation of these questions.

From the available evidence it may be said that the land conditions prevailed in Western Asia throughout the Silurian period.

Although the sharp faunal contrast as in the Ordovician, is still maintained in the Lower Silurian of the Himalayas and Burma, yet considering the paucity of the Himalayan fauna too much emphasis cannot be laid upon this point. In this connection Dr Sahni has drawn pointed attention to the entire absence of graptolites in the Himalayan Silurian and their abundance in Burma and China.

While the whole of Asia appears to have remained a land area from the close of the Lower Silurian to the end of Upper Silurian, a minor transgression with an American type of fauna invaded parts of Yunnan, Tonkin and the neighbouring region to the east of it in Upper Silurian times. There is therefore a profound physical as well as faunal hiatus in their Silurian faunas, for the Lower

Silurian faunas have European affinities while the Upper Silurian possess an American stamp. Dr. Sahni has suggested that the intercommunicating pathway between Europe and Asia probably lay north of the Central Himalayan region across Russian Turkistan and Timan whence Silurian fossils have been obtained.

The commencement of the Devonian witnesses, one of the most interesting episodes in the geology of southern Asia namely, the sudden influx of a fauna which bears no relation to the faunas of immediately surrounding regions, but is a prototype of the far Mediterranean Lower Devonian fauna. It is the fauna which is represented in the Bohemian region by the well known Hercynian facies. The most interesting and puzzling fact about this Zebingyi fauna is however not its isolation and Hercynian affinities, but its composition, which makes the question of its exact age indeed a perplexing problem. The question of advent of this South European fauna and its probable pathway of migration has been discussed in the paper. Dr Sahni has however assigned a Lower Devonian age to the Zebingyi beds inspite of the presence of Silurian graptolites. Another problem discussed is the place of origin of the Zebingyi fauna, as fossil evidences show that Shan region was not the birth place of this fauna.

The close affinity of the Eifelian fauna of the Shan region with what of Germany shows free inter-communication and rapid migration in spite of the long distance separating them.

The marine transgression which took place in Middle Devonian times has few parallels in the geology of Asia. This resulted not only in the intermingling of the Asiatic fauna of different regions, but also in the removal of barriers of Asiatic and European life provinces which gave rise to similar faunas in widely separated regions. The record of the upper part of the Middle Devonian (Givetian stage) is less clear in Western Asia as well as in the Himalayan region but evidence shows that transgression during this period flooded the present region of the Kwen-lun and Tian-shan mountains.

Regarding Upper Devonian time Dr Sahni has drawn attention to the paucity of record in the Himalayan region which was then presumably a land area. But Upper Devonian strata are developed in the Chinese basin, in the region north of Tibet and west of the Himalayas. It is therefore, probable that the Upper Devonian fauna migrated eastwards from Western Asia via the marine basin north of Tibet while the Middle Devonian fauna found a passage way south of the Tibet region, i.e., via the Himalayan geosyncline. Against this, however, are the views expressed by Bailey Willis who considers that Tibet was an island practically throughout the Palaeozoic era. On account of limited geological evidences, Dr Sahni in conclusion emphasizes that the final judgment on these various complicated palaeogeographical problems can be left only to systematic and continued future work.

N. N. C.

Geography and Geodesy

Conservation of India's Natural Resources

S. M. TAHIR RIZVI

CONSERVATION of natural resources is a timely field of action in India. The growth of population in this subcontinent has been accompanied by an unprecedented destruction of the natural landscape. The scientific geography though still in its infancy in India is contributing to the field of conservation both theoretically and practically. Studies in systematic and regional geography are greatly helping to build up our knowledge of our natural resources and the problems arising from their exploitation.

As the subject is a very wide one, the address was limited to three aspects of the problem, conservation of soils, forests and water resources.

Soil

The soil of a nation is its most material heritage. It is subject to certain changes when cultivated or pastured. The critical aspects arise when changes in soils that are subject to human manipulation are left to take a degenerative course, or are improperly directed, and when known means of maintaining the soils near their virgin level or raising them to higher levels of productivity are not employed. These critical aspects obtain rather generally in India.

Erosion constitutes a threat to the principal factor in our country's security—our indispensable agricultural lands. Under natural vegetative conditions, erosion is normal or geologic; but under cultural practice—the process is speeded to abnormally destructive rates. There are broadly speaking three types of erosion: sheet erosion, gully erosion and wind erosion. The harmful effects of these three forms of soil erosion go far beyond the removal of the valuable top-soil on which plants depend for their nourishment. The direct effect on pastures and grazing lands is to reduce the capacity of land for carrying livestock.

Erosion also has indirect results, of which the most important for us in India is the dumping of large quantities of sand in the river beds so that the

bed must inevitably be raised and thus aggravate the effect of floods. Another effect is to increase the severity of the intervening drought periods. This is because each small stream in the foot-hills discharges perhaps 80 or even 90 per cent. of heavy storms within an hour or so, and only a very small part of the rain soaks in the bare ground.

DEFORESTATION AND SOIL EROSION

Deforestation and soil erosion not only intensify floods and reduce the cold weather discharges of surplus streams but they also threaten the sub-soil water supply and impoverish the soil and reduce the output of agriculture.

American research has found that during the years 1935-37, the rate of run-off from completely denuded lands, such as is only too common on the banks of some of our rivers, such as the Jumna and the Chambal, is twenty times greater than it is from preserved forests. During one month of the flood season in Southern California, a watershed, which had been burnt out 4 years previously, was denuded of 120,000 cubic yards of top soil or a depth of 1·4 inches per square mile. On a similar watershed burnt out 19 years previously, the denudation rate was one-tenth of this, while in a watershed fully protected for the last fifty years the same rainfall only gave a denudation rate of one-thirtieth of this.

There are extensive waste and ravine lands in Agra, Muttra, Etawah and the adjoining districts. The ravines of the Jumna and the Chambal river form a practically compact mass the extreme length of which is 70 miles and the width about 13 miles in the centre. Natural reproduction here invariably dies down as soon as the rains cease. The natural vegetation of the ravine land has been destroyed by uncontrolled cultivation wherever the soil is fit for this, and by uncontrolled grazing, reckless destruction and by fires elsewhere.

Some of the worst erosion is evident in the Punjab Siwaliks, a range of hills skirting the

Himalayas where the hill grazer has accompanied or followed the wood-cutter and effectively denuded the soil of its protective plant cover. In many places damage is not confined to the eroded slopes, further destruction being caused by torrents (*chos*) formed by gully erosion, that sweep down the slopes during the monsoon. The *cho* is characterized by the steepness of its gradient and the violence and irregularity of its discharge. The torrent carries much suspended material which is deposited on the less steep lower slopes in a characteristic detrital cone which continually increases in radius and width. The *chos* debouching on to the cultivated sandy plains silt up the original drainage channels formed when hill erosion started, and the floods are forced out over wide areas. The floods subside as suddenly as they start, and all the water is lost to the land.

There is evidence that a hundred years ago the *chos* ran between well defined banks, and in some places perennial streams that could be used for irrigation issued from the hills. Reclamation might possibly be effected by closure of the land so that first grass, and then forest, could be re-established. Secondly, a drastic reduction in the surplus grazing animals is indispensable before any conservation programme can become effective. Beyond the most acute crisis of the whole land problem, there exists the physical fact that there can be no permanent cure of floods or prevention of stream and reservoir silting until run-off is better controlled, all the way from the crust of ridges down across the watersheds where floods originate and silt loads are picked up, on to the very channelways of streams, which have limitations upon their carrying capacity.

FOREST AND FLOODS

It has been often stated that a forest cover in a drainage basin materially reduces floods but forested areas are not free from the hazard of flood damage. Although the effect of forests upon run-off has often been overstated their effectiveness should not be depreciated.

Adequate flood protection is largely dependent upon engineering structures but the forest cover should be considered as a supplementary protective measure. A closely forested area with its absorptive leaf-litter delays run-off somewhat and gives greater seasonal uniformity to the discharge of the streams. Probably the most important effect of the forest cover is not in its effect upon surface run off but upon its protection of the soil, which in rugged areas is susceptible to removal, and when both the forest cover and the absorptive topsoil have been removed, all rains, no matter what their spacing, yield rapid run-off.

Due to the reckless extermination of forests by man or through excessive grazing, fires or over-cultivation, the area covered by forests in the United Provinces has been reduced to 4 per cent of the total area of the province and is confined almost entirely to the hills and sub-montane region. It has been estimated that about 20 per cent of the area of a country should be covered by forests. Large areas of forest land have been cleared for cultivation, which should never have been cleared as the soil is poor and incapable of supporting field crops year after year.

The renewable character of forest makes for a very practical phase of conservation. With sufficient forethought, the country's resources can be kept at a level more nearly commensurate with its needs for wood products and other forest services, and, at the same time, much of the land which is now unproductive but suited to growing trees may be put to use.

WATER RESOURCES

The problem of the manipulation of the enormous amount of water which falls in India varies with the humidity or the aridity of the area. Evaporation, run-off and ground soakage are not uniform, and unwise practices may increase run-off to a danger point and destroy the balance set up by natural agencies. Among the many problems of water are the control of floods, which, for example, have caused great losses of life and property in the eastern Gangetic plain; the control of low water stages which have hindered navigation, as on the Ganges and the Brahmaputra rivers, or have caused losses of crops; its use for navigation, power, water supply for cities and towns, and the removal of refuse from houses and factories; the erosive tendencies of rain and streams; the silting of streams and consequent deposition when stream flow decreases; its use for irrigation; the maintenance of the ground water supply and the stabilization of the water table, and the use of water as a recreational appeal. A water policy of the country should be so established as to yield the greatest benefit possible from our water resources and be so regulated as to serve the greatest need. At all events, one needs take the stand that water is a highly valuable source, too precious to be wasted.

In some places in India, the water table has been lowered beyond the level of efficiency by stripping the vegetation cover, as in excessive deforestation, and in the processes of extensive cultivation, soil erosion, and ditching. As an extreme example may be quoted the serious reduction in the base level of the Jumna River where flooding and scouring has lowered its bed at Etawah sixty feet in the last five centuries.

with a corresponding fall in the spring level. The cold weather level of the river is often 120-200 feet below the surrounding country. The effect of this upon the ground water supplies is obvious.

The chief characteristics of the Indian rainfall are its unequal distribution throughout the country, seasonal irregularity of precipitation and liability to failure or partial deficiency in many tracts. But, within individual tracts, remarkably wide variations in total annual rainfall are found. Such tracts include practically the whole of the Punjab and North-West Frontier Province, the United Provinces except the sub-mountain regions, Sind, a large portion of Bihar, most of the Madras and Bombay Presidencies, omitting the coastal belts, and portions of the Central Provinces. The concentration of the principal rainfall in less than a third of the year places a very definite limit on the agriculture of the country. Thus our agriculture cannot afford to depend exclusively on rainfall and it becomes necessary to provide the agriculturist with suitable irrigation facilities.

USE OF WATER POWER

The principal sources of power available in India are coal, wood fuel, oil, wind and water. Most of the coal raised in India comes from Bengal, Bihar and Orissa (the Gondwana coal-fields). Outside these provinces, coal is obtained from Hyderabad State, Central Provinces, Assam, the Punjab and Baluchistan. Rajputana, Bikaner and Central India also contribute a small amount to the total coal supplies of India. Indian coal is thus very unevenly distributed, the deficiency being especially marked in the case of the peninsula. The absence of coal supplies coupled with the high cost of railway transport acted as a great handicap to the growth of industries and this had to be overcome partially by the use of hydro-electric power. Many of the Indian forests are, however, confined to hilly tracts from which transport is a matter of great difficulty and expense. Moreover, it is doubtful whether the supply of wood fuel could keep pace with the demand for it for industrial purposes. The position with regard to India's oil resources has completely changed due to the separation from India of Burma from which nine-tenth of the indigenous petroleum was obtained. As the possibility of the oil-bearing areas in Baluchistan, the Punjab, Assam, etc., must still be regarded as problematical, it would be unwise to place much reliance on this particular form of power. There are, however, fair prospects for the development of water power resources at our command. These have been limited so far on account of the seasonal character of the rainfall making costly storage works indispensable. In spite of this limitation,

there are many potential possibilities of tremendous importance and within recent years considerable attention has been given to large hydro-electric power schemes.

FLOODS AND FLOOD CONTROL

Floods are results of many conditions working singly or in combination. Usually no single cause can be assigned the whole responsibility. The immediate cause of most floods, however, is the excessive run-off from precipitation of high intensity, though many other conditions may be necessary to cause a great flood. As high water menaced periodically the homes of the people the protecting dyke or embankment became one of the first methods of defence against floods. One of the simplest and most individual methods of flood protection is channel improvement. Embankments are very commonly associated with other local preventive measures used along the smaller as well as the major streams. Further the problem of flood protection may be partially solved by the use of preventive works in the head stream area of a drainage basin. Under certain conditions these storage reservoirs not only provide a solution to flood problems but may be used for other purposes such as water supply, power, irrigation, etc.

THE RESPONSIBILITY FOR FLOOD CONTROL

The prevention of floods is a responsibility which extends beyond the limits of the inundated area. The problem of flood control, however, is rather strictly confined to the drainage basin. So long as control measures involve only riverine works the plan would require the co-operation of river-side communities but as control is extended to include preventive measures the whole drainage basin should be organised into a unit. The obstacles which make difficult the realization of this ideal are many, and probably will stand in the way of a strictly regional organisation based upon the hydrographic basin. The co-operation should include not only an inter-provincial agreement but also a uniformity of laws to facilitate the work connected with flood control. The State's responsibility also extends to finance the operations. For such purposes excessive expenditures may be justified, but there should be a careful scrutiny of all flood-control plans to make certain that the benefits to be gained equal or exceed the cost of the protective works.

The spirit of conservation of natural resources, the president emphasized in conclusion, demands that we should recognize limitations to our individual rights in the matter of natural resources, and render best services in the execution of local, provincial and national projects of conservation.

Zoology

Some Aspects of Mammalian Placenta

A. SUBBA RAU

THE term 'placenta' has been defined by various authors. But according to the author, Mossman's definition is at once brief and apt. Mossman states that "the normal mammalian placenta is an apposition or fusion of the foetal membranes to the uterine mucosa for physiological exchange."

Various methods of classification of placenta of mammals have been attempted from morphological standpoint. The well-known types are the yolk-sac placenta and the allantoic placenta. From naked eye examination the placenta was also classified as to be diffuse, multiplex, zonary, cotyledonary or discoidal. The author has then given the classification of Weber (caducous and non-caducous), Huxley (deciduate and non-deciduate), Strahl (placenta vera and semi placenta), Robinson (conjoined and apposed) and Assheton (*placenta cumulate* and *placenta plicate*), who followed the binary system. But Otto Grosser has established a system of classification which has general approval and which constitutes a distinct advance over the binary system. He recognizes 4 types which may be summarized as follows:—

- A. *Placenta epithelio-chorialis* type as exemplified by the placenta of the pig in which all maternal tissues are preserved, the foetal trophoblast being apposed to the uterine epithelium.
- B. *Placenta syndesmo-chorialis*. In this type the uterine epithelium disappears to a large extent; and the trophoblastic epithelium is brought into contact with the maternal connective tissue as in the sheep.
- C. *Placenta endothelio-chorialis* constitutes the third type in which, with the disappearance of the uterine epithelium and connective tissue, the foetal trophoblast comes into contact with the maternal capillaries as in the carnivores.

- D. *Placenta haemo-chorialis* type in which uterine epithelium, connective tissue and maternal capillary endothelium disappear with the result that the maternal blood circulates in the lacunae formed by the trophoblast as in Rodentia, Insectivora, Cheirop-tera, Anthropoid Apes and Man.

Histology of the placental tissue has enabled us to understand to some extent the functional significance of the relationship of the foetal and maternal tissues. It is well known, however, that the foetal blood is always separated from maternal blood-stream and the nature of separation differs widely in different types of placenta.

The exchange of material between the mother and foetus is conditioned by a variety of factors peculiar to each type of placenta. The normal requirements of the foetus comprise proteins, carbohydrates, fat, water, salts and vitamins. The proteins are transferred as amino acids to the foetal blood but the exact nature of transference in different types of placenta is not known and research in this line will yield valuable information.

The rate of absorption and utilization of the carbohydrates by the mammalian embryo is known to some extent. In view of abundance of monkeys in India, the author suggests that an extended investigation on Primates other than man may be carried on in this line.

But the information regarding the transport of fat from the maternal to foetal blood stream is wanting. Recent researches have changed our ideas about the transport of fat. From the works done by various authors (Sinclair, McConnel, Bickenbach and others) it is now held that the fats may either pass directly across the placental barrier to the foetal blood, thence to the foetus by way of the umbilical veins, or that the maternal placenta may act as a secreting organ, taking up the fat from the maternal

blood stream, and passing it on to the foetal blood with or without modification. The views expressed above do not lead us very far, for we should bear in mind that the enzymatic activity of the trophoblastic cells may also play an important part. Further, the fat content of placenta decreases gradually with age. Reinvestigation in these lines promises fruitful results.

Our knowledge with regard to the nature of placental enzymes is meagre and a well-planned study, as Needham suggests, of a placental type which is readily separable into maternal and foetal parts is urgently necessary.

There is a considerable lack of reliable information about the rôle of vitamins other than that of 'E' which are supplied to the growing embryo. No information is also available about the mineral metabolism in the mammalian placenta.

Foetal respiration is the next important function of the placenta. It has been observed that the passages of two gases in opposite directions are determined by a variety of circumstances depending upon the nature of the placental structure. Haemoglobin is the vehicle of gaseous exchanges but its effect upon the respiratory activity needs consideration. The recent researches of Barcroft and his collaborators have demonstrated that the foetal haemoglobin differs from that of the mother. A much more extensive study with different mammals is, however, necessary to see whether the structure of placenta is in any way affected by the nature of foetal haemoglobin. The studies of Boor and Hektoen indicate that the carbon monoxide haemoglobin from different mammals is species specific. It may, therefore, be assumed that the respiratory functions of placenta are varied in different species of mammals. The whole phenomenon could be solved if the physico-chemical properties of the placental barrier with reference to the rate and intensity of exchange of materials are known.

With regard to phylogeny of placenta two views are extant. According to many zoologists (Hill, Grosser and others) the epithelio-chorialis type is

primitive and the haemochorialis type is highly specialized. The other view (supported by Wislocki, Mossman and others) is that the haemo-chorial type is primitive and that all other types are secondarily derived. An unbiased analysis of available data tends, however, to support the former view. But the most essential point is the foetal nutrition, the adequacy of which may be said to determine the normal development of the foetus. A vast amount of information regarding nutritional requirements of pregnant mother is available, but it can by no means be stated to be complete. The author, therefore, suggests that the newly established ante-natal clinics in Indian Maternity Hospitals are in a better position to take up the subject of nutrition of the pregnant mother for serious research.

The works of physiologists, biochemists and medical men have amply proved that efficient nutrition exercises an enormous influence on the general welfare of the animal and indirectly on the quality of the germ-cells which are formed afresh throughout the greater part of life. Recently, progressive governments have established Nutritional Research Laboratories to enquire into the nutritional needs of livestock and man. These laboratories have already turned out very valuable works of national importance and it may be hoped that attention would also be directed to a study of foetal nutrition.

From a rapid glance through zoological researches in India it appears that they are mostly morphological in the widest sense. These morphological studies, however useful and essential, must be made more dynamic. It is suggested that in India, as in the other more advanced countries, zoologists ought to take up experimental methods in their investigations which would yield very valuable results.

In conclusion the author pleads for a co-operative effort by the zoologists, physiologists, specialist medical men and biochemists in a well-planned study of foetal nutrition.

J. L. B.

Agriculture

Plant Breeding and Genetical Work in India

K. RAMIAH

DEALING mainly with two of the most important crops of the country, rice and cotton, Mr Ramiah describes at the outset the practical results of plant breeding in the country by the spread of improved types evolved by plant breeders and the consequent increase in the production of the country. In this connection he draws attention to the rather low acre yields of crops in India and emphasized the necessity of improving the agricultural statistics of the country, the figures now available are considered inaccurate. India is an old country, a big continent, with very divergent climatic conditions and rainfall, and the crops in a greater portion of the country have to depend upon the vagaries of the monsoon. It would not be therefore fair to compare acre yields of India as a whole with yields of similar crops in other smaller countries. He points out however that intensive methods of cultivation combined with the growing of improved types, have produced in isolated tracts acre yields comparable to those in other countries.

The methods of plant breeding which consist mainly of exploiting the genetic variability either in natural populations or hybrid progenies are then briefly discussed with Indian examples of the results of plant breeding. In this connection a brief reference is made to the question of growing mixtures rather than pure types and certain advantages in favour of the practice, obtained from actual experimental data with cotton, are pointed out.

A fair amount of genetical work during the last twentyfive years in India has tended more towards confirming the universal applicability of the original Mendelian laws and their later extensions rather than directly contributing to the improvement in plant breeding practices. This is due to the fact that such genetical studies have, in the past, concerned themselves mainly with qualitative characters whereas, what the plant breeder is really interested in refers mostly to plant characters which are quantitative in their inheritance and controlled by a large number of genes, each probably having only a small effect and impossible to distinguish in the later

generations of a cross. The accumulated knowledge in genetics has, however, been of great value to the plant breeder in that it has given him a clearer conception of his problems and a better understanding of the processes involved in his work. Similarly, the advances in cytology are of interest to the plant breeder in that they provide the chromosome interpretation of species relationship, the conception of polyploidy and the explanation of sterility and peculiar forms of inheritance. The knowledge that physiological characters like resistance to disease are also genetic in their behaviour has been of practical value and breeding for resistance to special diseases forms an ever increasing and important item in the activities of the crop botanists in India. There are already several examples of types bred with this end in view. The genetics of quantitative characters involves special statistical methods and improvement in the breeding technique so that, the variance in the breeding material can be divided up into portions due purely to environmental effects and portions due to genetic causes in the successive generations. The work on this aspect with special reference to cotton is in progress at Indore.

The problem of heterosis is of practical benefit in vegetatively reproduced and naturally cross-fertilized crops. Hybrid maize is mentioned as the most outstanding example of the practical application of the theory of heterosis in revolutionizing the production practices of an agricultural crop. With regard to correlations between characters in crop plants, they may be either physiological or genetic, and it is necessary to collect all possible information on the correlation of characters in crops. The question of using a "discriminant function" in plant breeding which involves the obtaining of critical evidence as to what quantitative characters are more influenced by environment than others so that the least variable character might be used as a criterion for making selections in the later generations of a cross is under study at Indore with special reference to cotton. The importance of the problem of wide

crosses and the study of the range of variability in a wide collection of crops, which aspects have come to the forefront because of the Russian work and the recent advances in the study of polyploidy is then dealt with. The question of crosses between species and crosses between geographical races within the species is then discussed with several examples in rice and cotton and indications given as to the most fruitful lines of attack. The serious limitations which arise in the getting of all desirable combinations from wide crosses are then discussed and the necessary modifications in the breeding technique explained to overcome the difficulties.

Due to various causes, genetic and non-genetic, the strains evolved by the plant breeder do deteriorate after being grown by the cultivators for a period. The complaint of such deterioration in simple selections from natural populations of self-fertilized crops is shown to be due mainly to non-genetic causes while deterioration due to genetic causes may result in crops where the theoretical homozygosity for any particular quantitative character is impossible of achievement. A very careful maintenance of a nucleus of pure stock of seed in experimental stations and a systematic scheme of seed multiplications is stated to be the only method at the disposal of the breeder to check such deterioration, and this should require greater vigilance and control when the strains released for distribution happen to be highly bred.

Unlike other aspects of agricultural research, plant breeding work is capable of giving returns several times in excess of what is actually spent on it. It has the additional advantage that the result of plant breeding research are taken up readily by the cultivator as it involves no additional expenditure on his part. While actual plant breeding work on crops involves a considerable amount of local adaptability and hence has to be carried on at several centres, there seems to be necessary to centralize at a few centres the basic researches. The only body that can be expected to take interest in a

systematic programme of genetic research in crops is the Imperial Council of Agricultural Research. This body is already financing several schemes of crop research in the Provinces and States, but probably with the exception of a few, such schemes are more of a local interest only. There is great scope for not only intensifying the programmes of basic research but also to co-ordinate the work done all over India to avoid duplication and waste of effort. Involved with the question of basic research on crops is the question of the introduction of crops from outside and also exploration of key regions to obtain forms of value to the plant breeders. There is now enough evidence to show that certain regions in India which, if explored, might give new forms in several of our cultivated plants. The obtaining of wild forms and the incorporation of useful genes from such forms into the cultivated types is now recognized as a practical line of attack in crop improvement. It is suggested that a Bureau of Plant Industry, somewhat on the model of a similar organization in United States of America, might be formed in India under the auspices of the Imperial Council of Agricultural Research. This body might be entrusted with the carrying on of basic research on crops at suitable centres, co-ordinating the results of such research in Provinces and States, taking charge of the introduction and trial of new crops from outside and exploring key regions for obtaining new forms of crops already under cultivation.

The recent developments in genetics have been very diverse embracing several aspects of biological research, namely, physiology, taxonomy, ecology, cytology, etc. This necessitates a change in the outlook in the teaching of these subjects in our universities, and in conclusion Mr Ramiah makes a strong plea for a larger share of genetics in the syllabuses of honours courses in biology in the universities and for a greater co-ordination between the agricultural departments and the post-graduate university departments of biology so that a greater output of basic researches in the country may be possible.

Physiology

Some Observations on Sleep

B. B. DIKSHIT

The 'classical experiments of Pavlov on 'conditioned reflexes' have shown that sleep is due to the inhibition of localised centres in the cerebrum spreading over to the whole of the cerebral cortex and thereby bringing about internal inhibition and sleep. Doubts have however been cast on this theory of sleep and it has been claimed by some workers that decorticated dogs in whom conditioned reflexes cannot operate, also can sleep. Further, existence of a 'sleep centre' in the mid-brain has now been recognised by many neurologists and Prof. Hess of Zurich has shown that electrical stimulation of certain hypothalamic centres by specially constructed electrodes can promptly produce a condition resembling sleep in cats. Pieron, who first advocated the chemical theory of sleep, thought that a substance having a hypnotic action is present in the cerebrospinal fluid of dogs artificially kept awake for prolonged periods. He termed this substance 'hypnotoxin'. Since Pieron's publication of his chemical theory, a number of substances such as calcium salts, compounds of bromine, choline derivatives, etc., have been introduced into the cerebrospinal fluid of experimental animals and as some of them produced a condition resembling sleep, claims have been made for them as 'sleep-producing hormones'. Acetylcholine is one such substance which has been extensively studied in this connection.

The slowing of the heart, fall in blood pressure, contraction of pupils, depression of respiration, and several other phenomena occurring during sleep led Prof. Hess to believe that sleep is a *parasympathetic* phenomenon. Clinically, attacks of asthma occurring more commonly during sleep and the successful treatment of narcolepsy by sympathomimetic drugs like ephedrine support Hess's view. The relation between the parasympathetic nervous system and acetylcholine has now been well established and from this point of view the claim of acetylcholine acting as a 'sleep hormone' appears to have some basis.

If this viewpoint has to be logically supported, it is necessary not only to show that a 'sleep hormone'

produces its action on the sleep centre but it must also be demonstrated that it occurs normally in the brain, that its action on brain centres are reversible and that the effects of its application to the brain centres resemble as closely as possible the effects seen normally during sleep. Further, it must be shown experimentally that this 'hormone' accumulates around the sleep centre during sleep and disappears from there on awakening.

In support of the 'chemical theory', it may be said that acetylcholine produces sleep when applied to the brain centres, it occurs normally in the brain and it disappears from a particular site due to the action of an enzyme—choline esterase. Its action on the different systems of the body, when applied to the brain, resembles some actions seen during sleep. Thus, it is quite well known that during sleep the blood pressure falls slightly, the heart beats somewhat slower, the respiratory centre is depressed and muscular movements are inhibited. Acetylcholine injected into the lateral ventricles of the brain produces all these symptoms. Further, application of acetylcholine to the hypothalamic centres produces cardiac irregularity and it is a common clinical experience that in persons suffering from certain irregularity of the heart, the irregularity is increased at the onset of sleep. It is a common experience in the tropics that the secretion of sweat is increased at the commencement of sleep and it has been found that intraventricular application of acetylcholine produces sweating in man. It should be noted that when acetylcholine is introduced into the ventricles of the brain it affects all centres lining the ventricular system and therefore its action may be much more complicated than that seen after liberation of the ester at a localised spot in the brain. Still, as discussed above, the effect of intraventricular injection of acetylcholine resembles in many instances the effects produced by normal sleep.

The crucial test of the 'hormone theory' of sleep must however rest with the actual demonstration of accumulation of the 'hormone' around the sleep

centre during sleep and its disappearance from there on waking. It has not yet been possible to obtain this direct evidence about acetylcholine, though the indirect evidence presented above is fairly convincing.

Diurnal periodicity of sleep in man is more a habit than a physiological necessity and therefore, it may, as has been advocated by Pavlov, be dependent on the cerebral cortex. We are accustomed to sleep under certain conditions and any change in these conditions may cause sleeplessness. Thus, a different pillow or a different bed room may prevent sleep. There is, however, always a limit to this sleeplessness, and when the real physiological necessity for sleep arises, it is possible to sleep in most adverse conditions. Instances have been

recorded during the last war when men were riding or marching while actually sleeping. Further, if sleep is a conditioned reflex it is difficult to understand how a new born baby sleeps from the moment it is born. The sleep of polyphasic animals like the rabbit who have more than ten periods of sleep and activity during twenty four hours is also difficult to understand from this point of view. Sleep as a physiological necessity therefore cannot be said to be entirely dependent on the cortex and the function must be assigned to the hypothalamic centres. All experimental evidence seem to indicate that this hypothalamic centre can be activated by acetylcholine and therefore it is not improbable that acetylcholine may, in the near future, be recognised as the true 'sleep-producing hormone'.

B. M.

Psychology

Psychology and the Future of Mankind

I. LATIF

It appears that modern civilization in whose friendly support man had placed his implicit confidence is likely to prove his most dangerous foe. His supposed safety and stability within civilized society is now being exposed as an illusion and the destiny of the human race is becoming increasingly dark and uncertain. Not only have the perils of his physical safety been increased, but due to irrational control over his fundamental natural urges his sanity is being steadily impaired. The number of the victims of psychogenic disorders is definitely on the increase. The records of the United States of America show 150,000 suicides annually. Crime is progressively thriving in our modern society. There is unmistakable rise in cases of neurotic disorders, domestic and martial disruptions, and delinquencies. Mankind appears to be inextricably involved in a vicious circle, so that mental disorders, crimes, political unrest, wars and unhappiness dog its steps at every turn.

The most pathetic aspect of the situation is the profound ignorance of the leading intellectuals con-

cerning the real causes of the manifold disorders with which mankind is afflicted. Consequently little or nothing has been done to alter this situation. Few attempts have been done to explore the mental dynamics of the *Homo Sapiens* in a scientifically objective manner in order to discover the underlying causes at work. Without proper study of the mental dynamics it is not possible to understand adequately and remedy effectively the present trouble so as to ensure the sanity and stability of the human race. Without the help of psychopathological insight and technique, the situation will for ever remain an inextricable mystery and a constant menace to mankind.

Several factors have obscured the importance of the knowledge and application of the findings of psychological research in the scientific study of human affairs. In the first place, the extraordinary progress of the physical sciences has naturally led to the relegation of the mental determinants of human behaviour into the background. The bias for physical sciences characterizes the mental outlook of a majority

of our leading scientists. But there is a more important factor. The indifference and hostility to psychology can be traced, in the last analysis, to the great unwillingness of man to face himself. It appears that a large majority of the opponents of psychology are people who by the rigid restraints of modern culture are unable to encounter calmly the contents of their own mental make-up. Their indifference to this science is, to a large extent, a defence mechanism against the possibility of the revelation of certain mental dynamics which are, so to say, looked upon as contrabands within the social environment of modern culture. With his extraordinary insight into this fact Sigmund Freud has clearly demonstrated how human beings can ill-afford to endure any shock to their narcissistic self-complacency and that contempt for any scientific technique which bids fair to ensure self-knowledge to the individual is very often used as the principal weapon of the resistance. This resistance incidentally is a measure of the mental health of modern society.

It is a false notion that the mental structure of the civilized individual is fundamentally different from that of his savage ancestors. The vast and varied data now available in the field of psychoanalytic research clearly indicate that fundamentally the same mental dynamics which motivated the behaviour of his savage ancestors thousands of years ago, still, under the gloss of modern culture, continue to determine the conduct of modern civilized man. Behind man's facade of rational conduct there exists a primitive mental structure which regulates his individual and social life. Modern man has not been able to shake off the influence of the primitive processes which existed in the darkest phase of human development.

To understand how the savage elements of our nature remain generally unrecognised in our conscious mind it is necessary to have knowledge of the psychological mechanism of 'repression'. Repression is a process through which an impulse which comes into conflict with a strong cultural demand is driven into the unconscious. This process is further aided by another unconscious mechanism called projection through which the individual unconsciously responds to the conflicting urge by an effort to deny its existence within himself and by attributing it to an external object. The latter, to some extent, accounts for the extraordinary conviction with which certain paranoics attribute guilty motives to their neighbours. This also to a very large extent explains the abnormal zeal of the religious fanatic or the hypercritical prude. The more violent is their condemnation of others, the stronger are their repudiation and fear of these impulses within their own lives.

It has been said above that the trend of the current events seems to indicate that mankind is steadily heading towards self-destruction. The only way of escape consists in the intelligent use of scientific psychology in effecting the mental and emotional re-adjustments which appears to be incumbent on human society today. A society which has developed the use of scientific psychology is already on its way to sanity and stability. It may be said that every individual is gifted with a reasonable degree of common sense which enables him to make the necessary adjustment in his life without the help of scientific psychology. But it is not the conscious aspect of human behaviour which alone stands in urgent need of being scientifically understood and readjusted. The vast and uncharted field of one's unconscious motivation must also be clearly cognized and rationally re-oriented. Common sense without the help of psychological knowledge and technique is unable to meet the requirements of this complicated task.

The following are some of the ways in which psychology can help human society to readjust itself so as to secure its future stability. In the first place, since the present crisis in the affairs of mankind is mainly due to the irrational restraints which society has come to exercise on the instinctual demands of the individual, it is of fundamental importance to correct our attitude towards these demands. In the second place, psychoanalytic treatment must be made more generally available than it is at the present moment. Then, the work of ensuring the sanity of mankind through psychological control should begin in the nursery. The psychological upbringing of the child is the first step towards the mental health of the adult. The education of the child must be permeated through and through with the methods and principles of child psychology and mental hygiene. It is necessary to urge the need of psychological clinic for children. All that parents and teachers can do, if they have received psychological training, is to avoid those cases and conditions which may lead to the formation of neurosis in their children. But they cannot treat a neurosis after it has set in. Clinical help is essential in such cases. The help of psychological clinics is specially needed in the treatment of cases of juvenile delinquency. In this connection it has to be mentioned that parents should be enlightened about their obligation to the children in the field of sex education. A large number of sexual maladjustments have their roots in the subtle lies with which parents had attempted to discourage accurate knowledge on the part of their children. Another way in which psychology will be found to have supreme values for the task of social

re-orientation is the application of its scientific findings in the field of vocational selection.

Various lines of evidence point to the fact that mankind has reached a critical point in its life history where two alternatives irrevocably confront it. It must either seriously set about the task of emotional

re-education and mental re-orientation towards problems of human life and experience, or it must face the alternative of self-extermination. Re-education of man is the present task of psychology.

S. K. B.

Engineering

Hydrodynamic Models as an Aid to Engineering Skill

C. C. INGLIS

In this address, in which large numbers of references and examples are quoted to substantiate his statements, the author says "there are few subjects concerning which so much confusion of thought exists as on the correct role of hydrodynamic models.

There is a marked tendency for engineers either to hold that models give highly reliable results, or that they are untrustworthy, and must be viewed with grave suspicion.

The main reason for this confusion is due to hydrodynamic models being of several markedly different types, some giving highly accurate results, while others produce results which diverge widely from what occurs in the prototype; so that river conditions must first be translated to model equivalents and model results translated back to river equivalents." He divides models into 4 main types.

Type I covers models which give similar results to those of the prototype provided care is taken to reduce friction losses proportionately or to allow for divergences. This type includes a large proportion of geometrically similar rigid models dealing with discharge coefficients, lines of flow at offtakes and standing wave relations, including scour downstream of falls.

Type II consists of geometrically similar models which do not give geometrically similar results. Important exceptions are quoted. In the case of high co-efficients weirs, co-efficients of discharge increase with depth and also with scale of weir. Similarly, the specific gravity of slabs of submersible bridges which just do not get washed away, increases with scale.

Type III covers mobile bed models in which flow pattern is the dominant factor. Piers and groynes are given as examples. It is explained that the channel in which a pier is placed follows one law, whereas scour in the vicinity of the pier follows another.

Type IV deals with vertically-exaggerated river models of three types:—

- (a) rigid
- (b) semi-rigid
- (c) mobile.

(a) In rigid river models the usual practice is to fix a suitable vertical-exaggeration, estimate the mean roughness required, and then verify slopes for known discharges. If the slope is in error, the roughness is altered until it becomes satisfactory. This is a slow process; because changes made in one part of the model affect other parts. Then again, though the model may give satisfactory results with one discharge, it may give unsatisfactory results with a larger or smaller discharge and a uniform roughening will not give correct results. A large amount of data and much patient 'trial and error' work is therefore necessary. After such verification it is assumed that correct levels will be obtained for conditions outside the verified range—as, for instance, in a flood of greater magnitude than previously observed or when different slopes and local intensities of flow occur, due to peak floods in tributary streams reaching the main stream at different times from those of previous recorded floods. Such models can undoubtedly give most valuable information as regards flood levels, lines of flow, and points where violent action will occur under such conditions; but the model, being

rigid, cannot give direct information about scour, which must be inferred by the experimenter, nor will the flow for such conditions be correct; because in nature heavy scour would cause marked changes in conditions.

Type IV (b): In semi-rigid models the sides, and in some cases large parts of the bed, are held. This, by making it practicable to enforce a vertical exaggeration in excess of what is natural, makes it possible, while retaining the same Froude Number as in the prototype, to increase the slope, and hence the silt charge.

This makes it possible to reproduce similarity much more accurately than is possible in a fully mobile model and so simplifies interpretation. On the other hand, it imposes conditions throughout the length of the model and the model cannot scour its banks, which are rigid, nor change its course; and if, as is generally the case in India, the question we desire to investigate is 'future changes of river course and the secondary effects of such changes', we must, when using models in which the sides are held, predict the changes and the rate of those changes, to enable us to determine the secondary effects which will result from those changes.

Type IV (c): In 1929, Gerald Lacey of the United Provinces (India) produced a set of regime formulae for constant conditions of discharge and silt. Under such regime conditions there are only two independent variables (excluding temperature): discharge and silt. Lacey's formulae stated in terms of these two variables are:

$$\begin{aligned} P &= 2.667 Q^{1/2} \\ R &= 0.472 (Q/f)^{1/3} \\ V &= 1.1547 \sqrt{fR} = 0.7937 Q^{1/6} f^{1/3} \\ S &= .000542 f^{5/3} / Q^{1/6} \end{aligned}$$

Where Q = discharge; f = a silt factor,

p = wetted perimeter;

R = hydraulic mean depth;

V = Velocity; and S = slope.

The first three of these formulae have been confirmed by several years' statistical investigation in the Punjab where the mean silt diameter is of the order 0.32 mms. ($f=1.0$). From the first two of these formulae it is seen that $\frac{R}{P}$ —the hydraulic shape ratio—is not a constant but varies inversely as $Q^{1/6} f^{1/3}$. In other words, the smaller the discharge and the finer the silt, the greater the depth relative to the width;—showing that vertical exaggeration in models is a natural law.

Slope exaggeration varies as $f^{5/3}/Q^{1/6}$; so that whereas a coarser silt increases 'slope exaggeration', it decreases 'vertical exaggeration'; and SE/VE , which has been generally assumed equal to unity in model work, varies as $f^{5/3+1/3} \propto f^2$. Lacey's assumption that channels in incoherent alluvium are semi-elliptical in shape, leads to his formulae giving a limiting velocity of 0.882 ft./sec., irrespective of silt; because

$$P/R = 2\pi = 6.28 = 7.12V.$$

It was found at Poona that this value tallied approximately with the velocity at which silt of 0.03 mms. mean diameter just ceased to move in a natural channel; and, on plotting all data available, it was found that the velocity at which silt ceased to move varied approximately as $(V - V_{rt})$, where V = mean velocity, and V_{rt} = the velocity at which silt ceased to move; but whereas Lacey's limit was unaffected by size of silt, V_{rt} varied approximately as $m^{1/3}$, where m = mean diameter of silt in millimetres.

From this it follows that silt movement, always relatively much less in a natural mobile model than in its prototype, will start in a river with a relatively low discharge and will continue until the discharge again finally falls to this same low value; whereas in a model, with a flood velocity of say 1.5 ft./sec., silt movement will not begin until the discharge is equivalent to about half the flood discharge. This is a serious limitation in mobile river models which can only be partially neutralised by scaling up small discharges in the model or increasing the slope.

Another complication is that whereas in rivers the greater part of the silt is in suspension, in models most of the silt is in the form of bed sand.

Further complications result from vertical exaggeration of rigid structures and bank slopes. The width of scour caused by groynes and other rigid structures is greatly exaggerated in models, due to the depth being exaggerated while the flow pattern is similar in shape.

Vertical exaggeration of the banks of models also tends to establish deeper channels along the banks; and as steep banks exceed the angle of repose of all except rigid materials, natural bank scour is precluded. In practice, therefore, the choice lies between rigid, steep, sides, and mobile, and hence relatively flat, slopes, which take up much too great a width of the model.

Longitudinal distortion is yet another difficulty. Normally longitudinal scale is equal to latitudinal scale; and vertical exaggeration is made equal to

slope exaggeration. This is done to prevent distortion in plan. This means that the length scale is foreshortened to the same extent as the vertical exaggeration ; which means that the length in which new lines of flow or eddy-patterns have to become established in the model as a result of changes of section or roughness is inadequate in the model to establish the prototype change before a further alteration in the angle of flow or roughness occurs.

Finally we come to the difficulties inherent in imposing correct entry conditions : No matter how long a model may be, entry conditions, on which changes in a meandering river largely depend, and to a smaller extent, exit conditions, must be correctly imposed.

In a relatively short river model, much greater control is possible and much more silt can be kept in motion than in a longer model ; but the results also depend to a much greater extent on the accuracy of the conditions imposed at entry, *i.e.*, the distribution of silt and curvature of flow of the water. To impose these correctly is always difficult, necessitating a deep understanding of field conditions, which must be accurately diagnosed and completely visualised before their effects can be correctly imposed. Obviously those who can diagnose upstream conditions can also foresee, with equal accuracy, what the model-portion of the river will do ; hence the skilled experimenter knows very approximately what result the model should give when he is designing it and before he carries out experiments.

The impression created may be that river models cannot be expected to give useful information. That, emphatically, is not my view ; but any idea that all one has to do is to construct a vertically-exaggerated scale-model of a river and that it will automatically give the correct answer is nonsense.

Natural mobile models do not give similarity, but only results which are capable of being translated approximately from river to model and back to terms of river conditions ; so that results necessarily diverge more and more as the period of the experiment increased.

The model divergences can, however, be allowed for to a considerable extent by applying data obtained in subsidiary experiments with part-models and by making corrections for scale effect.

The general conclusion is that in competent hands, a very wide range of experiments with large models gives results of high qualitative accuracy and may also give quantitative accuracy ; but, in the case of river models, the data available is generally meagre, and the problems which generally have to be tackled are of immediate urgency, the discharge data being inadequate and the silt charge data nil, and we are asked 'what will happen if nothing is done?' or 'what should be done to prevent further damage?'

Satisfactory answers depend to a marked extent on an intimate knowledge of the engineering side of the problems under consideration combined with a flair for diagnosis.

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Fuel Economy Policy in India and Abroad

We are reverting to the question of fuel resources as we believe the problem has not yet received the attention it deserves from the public. People have come to realise the deplorable dependence on imports for our living and the question of starting the essential or key industries has been the popular subject of discussion. The opportunities created by the present war for the growth of industries and the nourishment they require at the initial stages have apparently been discussed in the press and on the platform. The efforts of the Government to utilise the occasion are however choked up in the mists of conflicting interests and for a planned policy of exploiting the available resources, except in so far as they concern supply of materials for the prosecution of war, the support, if any, has been rather lukewarm. But private enterprises are coming into the field and they are struggling under more than one handicap. While much has been studied with regard to the different commercial and manufacturing aspects concerning the particular industries, the problem of fuel economy, which is the general concern of almost all industries, has not unfortunately merited the serious consideration of the industrialists of the country.

Fuels play a fundamental role in the industrial activity of a country not only as a source of heat, but also as one of the principal sources of power. As industrial prosperity is an essential factor in a nation's political status, the importance of efficient consumption of fuel resources needs no special

emphasis. With the exception of wood and power alcohol, however, the fuel resources, namely, oil and coal, are irreplaceable in character. A ton of coal or petroleum consumed today means a permanent reduction of that amount from the country's total reserves. Fuels naturally require more attention than minerals as a ton of metal even after use may remain in the form of scrap to the extent of at least half the quantity. There is thus a method open for increasing the life of metallic reserves by launching a policy for increased use of scrap. But no such measure can be adopted for conserving natural fuels.

In addition to being a source of heat and power, coal is one of the indispensable materials required in the smelting of iron ores. It also provides raw materials in the manufacture of numerous dyes, synthetic perfumes, drugs, antiseptics, plastics, manures, solvents and a host of other valuable products. Being therefore one of the principal sources of power and indispensable to the metallurgical and several other industries, coal is of paramount importance in the defence of a country.

Nature has not been equally generous to all the countries in the matter of fuel resources. The United States of America alone possesses more than 50 per cent. of the total natural fuel reserves of the world. Moreover, she possesses fuels of all kinds. Germany and Great Britain are very poor in oil resources but possess abundant resources of coal. Sweden and Switzerland have practically no resources

of natural fuels. For some of the metallurgical processes they have to depend on other countries and for power supply they have developed water power.

With regard to liquid fuels, however, the position at present is distressing for the whole world. In comparison with the distribution of coalfields, oilfields are localised in a few countries only. Moreover, in spite of very active and efficient prospecting, oil fields in the world capable of satisfying world requirements appear to be very limited, and the present known reserves at the present rate of consumption are not expected to last for more than 60 years. It is evident, therefore, that taking the world as a whole the problem of liquid fuels is more acute than that of coal and in spite of the increasingly efficient methods of utilisation, we are bound to feel its effects probably even in our own life time. The trend of future efforts will have to be in the direction of discovering substitutes for liquid fuels. Such efforts are already in progress.*

The realisation of the fundamental role of fuels in the prosperity of a nation coupled with their irreplaceable character implying early exhaustion of reserves has induced all the advanced countries to adopt a policy of the strictest fuel economy and conservation in some form or the other. A common problem faces all the countries, howsoever well-provided at present, as to the ways and means of effecting the best and fullest utilisation of the natural fuels. The problem affects the different nations so deeply that international conferences† of scientists, engineers and politicians on questions related to fuel and power resources have been called more than once. These meetings have proved very useful as they helped efficiently in formulating policies for the participating countries in the light of the experience gained by all of them.

India has very limited reserves of coal which form the principal source of power to her, in view

of the scanty resources of liquid fuels, specially after the separation of Burma. Even at the present rate of consumption (which is bound to increase with the expansion of the industrial activity of the country), the present reserves of good quality coal will not last for more than hundred years and those of coking coal for not more than sixty years. With the early exhaustion of coking coal, the manufacture of iron and steel which is an important and indispensable key industry, will be seriously affected. A new process using reducing gases and dispensing with the use of coking coal is said to have been discovered, but it is at present costlier in operation, and thus countries having no reserves of good coking coal are at a very great disadvantage so far as smelting of iron and steel is concerned. We are afraid that India too, in spite of her possession of very rich reserves of iron, may find herself in the same predicament as Sweden, which has to export all its iron ores to countries possessing coking coal and then purchase iron from outside.

At present most of the coal seams that are being worked up in this country contain coal of superior quality and occur in great thickness at shallow depths. With increasing consumption, the mining operations will have to be carried out at greater depths, the seams will be narrower, the mining operations more difficult and will cost more, and further the quality of coal will be inferior. The day is not far off, when due to the combined effect of all these factors the price of coal, even of the inferior quality, will be appreciably high. A situation will thus arise when industries depending on coal will be in serious jeopardy. Before such a crisis appears more efficient methods to provide for the future require to be adopted. These may involve extra expenses which will be reflected in the price paid by the consumer. But this extra cost could, in our opinion, be so graded as not to disturb the market. It is possible to adjust the higher price movement with market conditions. Higher prices will provide the incentive to improved (as contrary to wasteful) and new methods of utilisation. This will partially contribute to neutralise the effects of the high price. Sir Ardeshir Dalal in his presidential address at the last Benares session of the Indian Science Congress indicated briefly the means by which the varying qualities of coal can be put to different purposes so as to ensure efficient use of the coal resources of the country. Besides the co-ordinated sequence of working the coal seams, on the consumption side

* Germany realized the gravity of the liquid fuel problem much earlier than other nations, and set up nearly thirty years ago, a Kaiser Wilhelm Institut für Kohlforschung. As a result of the researches carried out at this Institute, modern methods of conversion of coal into liquid fuel have been developed, such as the Bergius method and the Fischer-Tropsch process. It is now well known that but for these researches, Germany could have never solved her liquid fuel problem.

† The first World Power Conference was held in London in 1924. After this two more have been held; the second at Berlin in 1930 and the third at Washington in 1936. The fourth World Power Conference was to be held in 1940 at Tokyo, but owing to the abnormal international situation as a result of the war, it had to be postponed.

he has suggested a chemical and physical survey of our coal seams in conjunction with coal utilisation research under the auspices of a Fuel Research Board.

The guiding principle in the conservation of non-replaceable resources of natural fuels is efficient exploitation. There should be efficient production and wise consumption which means that we are to encounter primarily two parties in the field—the producer and the consumer. From the standpoint of the producer, efficient exploitation of natural fuels may mean their working or extraction by any method, howsoever wasteful to the nation. The producer's objective is to secure a reasonable margin of profit. The consumer, on the other hand, would want that fuel of uniform quality should be supplied to him, at the lowest possible price. It is evident therefore that in an uncontrolled market the producer in order to be sure of his immediate profit, and at the same time to satisfy his customer's demands, will be tempted to adopt practices which may be wasteful to the nation as a whole. It is here that the State as the custodian of the nation's welfare has to intervene and prevent the individual producer or consumer from wasting an irreplaceable national commodity.

In a previous issue* we have discussed at sufficient length the position of the Indian coal industry. Apart from the wanton waste of coal reserves in our country during production, the superior qualities like the coking coals are being indiscriminately consumed for purposes other than metallurgical. The question of conservation of coal has been emphasised ever since 1919 not only by individuals but by representative committees and government authorities. The bureaucracy has been fully aware of the state of affairs prevailing in the industry which is evident from the remarks (quoted in the article referred to above) of such a high official as Sir James Sifton, late Governor of Bihar, which is the major coal producing province of the country. But the Government have been singularly indifferent towards this growing national emergency, the chief plea being the inability to interfere with the rights of the permanently settled zemindars of Bihar and Bengal, who are the principal owners of the coal property. But it may be pertinent to enquire what steps have been taken to prevent the same wasteful practices in the Central Provinces coalfields where the landlord problem does not exist as the mineral

rights are invested in the Government. The profession of sympathy for the rights of landlords therefore appears to be mere eyewash; the real cause of indifference is to be sought elsewhere. When one takes into consideration the anxiety felt by other countries possessing far vaster reserves in comparison with ours, and the steps they are adopting for proper exploitation and utilisation, the inactivity and the indifference of the Government to this fundamental problem appear to be really distressing.

In this connection the following lines from the reports of the Third World Power Conference will be worth consideration for a correct approach to the problem.

"Although the resources of the United States, to all intents and purposes would seem to be almost unlimited, nevertheless there is no justification for wanton waste in the utilization of such resources and efforts should therefore be directed towards increasing the efficiency of the use rather than arbitrarily restricting them."

* * * *

"Though the coal reserves of Germany are very great, they must be handled carefully as a national wealth so that all quantities that are at all accessible may be utilised."

* * * *

"The conservation of natural resources is recognised as a vital problem in all civilised countries, though the methods of dealing with the problem differ in different places."

In India the coal industry has been developed in an uncontrolled atmosphere and there has been notorious lack of co-operation amongst the colliery owners themselves. Whenever a proposal has been made for Government control, the principal coal organisations and colliery owners have vehemently opposed it as is evident from the following remarks :*

"I fail to see how, from any point of view we can possibly agree to a movement which will cause positive hardship to those it is intended to protect, which will increase the expenses of coal-getting by fully 50 per cent, and will, in similar proportion, add to the difficulties of all the industries in the Empire." "We feel that an attack upon the coal industry of Bengal means an attack on every other industry of Bengal in which coal is used, and such being the case it is not to be wondered at that we are prepared to resist, with all our strength, any blow aimed at the Bengal coal industry."

* Third World Peace Conference, 6, 495, 1936.

* *Ibid.*, 9, 288, 1936.

* *Ibid.*, 9, 379, 1936.

* Quoted from the Annual Dinner Speech, Min. Met. and Geol. Inst. India, 1931.

The chairman of the Bengal Coal Co., at the annual general meeting of 1936 pointed out that India's coal resources did not warrant any consideration of schemes of conservation and said that no shortage of coal is to be feared for over 100 years.

"It appears to me that the public as a whole do not sufficiently appreciate the importance of the principle involved in this question of conservation. It resolves itself into this. Are you, and all other shareholders of coal companies, quietly and peacefully to enjoy your properties as laid down in your leases with your landlords, or are you only to enjoy them subject to what Government decide you may or may not do in the presumed interest of posterity a hundred years hence? To me there can only be one answer—Government have no cause in this matter to trespass upon your rights, and I hope that upon reflection you and the public, as a whole, will agree with me."

Before the Coal Mining Committee of 1937, two witnesses who were mining engineers but were presumably under the influence of the colliery owners remarked as follows:

"I do not think that the State can prevent a private individual from working his coal as he pleases without giving compensation even though the result of such working may be to increase dangers from fire. I think that the mine-owner should be allowed to judge for himself whether he should take the risk or not."

"The owner of a colliery is the best judge of what is commercially valuable and his ability to work and sell at a profit any particular coal should be the criterion of its value at any time."

It is apparent that the colliery owners have been chiefly concerned with the question of profit. In the absence of control either by the landlords or the Government the safety of property, whose rights were unfortunately invested in the former, has been nobody's concern. The hostile attitude of the colliery owners was clearly demonstrated by the refusal of representative organisations (Indian Mining Federation and Indian Mining Association) to tender evidence before the Coal Mining Committee of 1937, even on the latter's repeated requests.

The complications are such that the only body that can effectively control the industry and stop these wasteful practices is the State. The National Planning Committee has appropriately recommended that the State should acquire the mineral rights, thus eliminating the private landlords. This procedure is not revolutionary since in many countries the mineral rights are vested in the State and even in the United Kingdom, the strongest citadel of plutocratic democracy, a bill to that effect was recently passed by Parliament.

The policies adopted by the different countries have been indicated in the reports of the Third World Power Conference.

"In Germany national policy aims to avoid the deficiencies both of a planned economy and of *laissez faire*. The basic concept is that "operating" must be left to business (the term business covering municipal and other public enterprises), but that the State must have means of influencing private initiative in the interest of the nation. The Energy Economy Act of 1935 is based also on the concept that electricity and gas are especially important to the State, that both are monopolistic, that absolute reliability is vital and that therefore there must be firm direction and co-ordination in the interest of the nation. General direction is in an 'autonomous body of utilities within the newly created organization of national economy'; but, notwithstanding flexibility of laws, the Government is given a strong body of administrative powers in the Reich Minister of Economy."

In Hungary the industry is also controlled by the State.

"Besides being protected by competition and by their representative bodies, the interests of consumers are also protected by the Government. The Ministry for Industrial Affairs and the Price Analysing Committee watch even the slightest price fluctuation and keep the prices stabilized by means of the regulator of import restrictions. The production of the coal mines is regulated by demand. Over-production cannot result for the products of Hungarian collieries, with the exception of Lias coals, which cannot be stored for long periods."

With regard to the United States the following lines are significant.

"The Government has also been active in relation to the development of power. The Federal Power Commission, formed in 1920 to control water power, has also been given broad powers for the regulation of other phases of the public utilities."

In the principal coal producing countries, some form of control is thus being exercised and in those which are still following *laissez faire* policy, the necessity of State control is being realised. There is no reason therefore why India should make further delay in adopting effective measures to prevent wastes of her very limited fuel resources, when there is a gradual depletion of the reserves and her consumption is increasing.

In this connection it is interesting to note the following remarks taken from the General Reports of the Third World Power Conference.

* *Ibid.*, 9, 407, 1936.

* *Ibid.*, 9, 291, 1936.

* *Ibid.*, 9, 382, 1936.

"One of the most striking features of the reports submitted to this conference is the clear-cut evidence that unrestricted competition as we knew it early in this century has been generally abandoned as far as the coal industry is concerned. Nearly all countries apparently have found that an unregulated system of production brought results that were socially undesirable. Consequently, in all parts of the world public control over the production and distribution of coal has been tightening."

Further,

"Our business systems may be capitalist or socialist or a combination of the two. Our governments may be democratic or absolutist. But under all forms we must organize our activities to meet the demands of natural law. Towards that end the civilized nations, each in its own way, are now struggling."

"In all civilized countries the care of man's working power has always been recognized as part of the State's responsibility. The technical and economic development of our age has provided man with mechanical energy as a most valuable ally. It, therefore, stands to reason that the way in which the supply of energy and all questions pertaining thereto are organized is of paramount importance as a factor determining the efficiency of national economy."

The preceding observations support our contention as expressed earlier that the problem of fuel resources comes within the purview of the field of politics, because, its solution implies a certain degree of intervention by the public authorities. It can no longer be a question of purely liberal economics, but of a liberal economy tempered by State control, or

better of economy completely controlled and directed by the State. We believe the situation has been laid adequately bare and the subject being of primary importance should come in the forefront of public thought and engage the serious attention of the people.

In conclusion, it will be appropriate to say that to squander irreplaceable resources is equivalent to squandering capital which is something like a trust to us—a trust which does not accumulate any interest, but goes on continuously diminishing. There should be effective checks to prevent waste and misuse. At the same time, the aim should not be to restrict their use, but to utilise them economically and devise means for their conservation.

There is now much talk of industrialisation in India. It is also admitted that power and consequently fuel supply is *sine qua non* of industrial development. When therefore there will be organised industrialisation, with her present *laissez faire* fuel policy India will soon find herself crippled with regard to power resources and under the force of circumstances she will again fall an easy victim to other industrialised nations. The State owes a responsibility in this matter. It is expected that at this present juncture, the Government after their long and continued inactivity will early adopt a new fuel policy in the wider interests of the nation as a whole. The other countries possessing vast resources in comparison to ours are taking effective measures in this direction and further delay will only result in disastrous consequences to the nation.

¹ *Ibid.*, 9, 279, 1936.

² *Ibid.*, 9, 384, 1936.

³ *Ibid.*, 9, 497, 1936.

Ceylon and North India—A Geographical Antithesis

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AS a geographical entity, the whole of North India—the Indus-Ganges plains tract as well as the lofty chain of the Himalayas that surround it—is a region of extraordinary interest in the framework of Asia. This interest arises from the magnitude and intensity of the disturbances the earth's crust has been subjected to in these parts, involving the creation of the world's largest mountain-system and the simultaneous sinking down of an equally large tract at its foot into a great hollow or trough. This interest is greatly increased when geological facts tell us of the extreme recentness of these world-transforming events to our own times. What was before a sea separating Europe from Asia and Africa, was turned into the loftiest chain of mountains. From evidence available from the structure and rock-records of this part of the Himalayas there is clear proof that some of the ranges of the Kashmir Himalayas, *e.g.*, the Pir Panjal range, have been upheaved from 5,000 to 8,000 feet, since the advent of man on earth, and that the Great Plains of the Punjab, U. P., Bihar and Bengal represent a filled up hollow or trough at the foot of the Himalayas by river-borne silt and sand to a depth of several thousand feet. The estimate of the depth of this alluvium vary from about 6,000—15,000 feet. These colossal changes in the geography of India, according to irrefutable geological evidence, happened at a date, which comparing the geological history of the earth with human history, may be called yester-year. Mountains, an interesting paradox of geology teaches, are the crumbings and corrugations of the weak and flexible zones of the earth's circumference. A visual demonstration of this fact is afforded by the magnificent sections of the rocky crust exposed to view in the precipices of the Himalayas facing Tibet, to the north of the central snow-clad axis of the range, wherein over 30,000 feet of marine sedimentary strata are seen deposited layer on layer, belonging to suc-

cessive periods of earth-history, from the commencement of the Palaeozoic era, the dawn of the earth's history to the beginning of the earth's Tertiary era, the age when the earth began to be peopled with animals and plants of modern aspect. That this vast pile of strata was laid down on the floor of an ancient mediterranean ocean, now extinct, is borne out by the succession of fossilised marine creatures belonging to the various ages that are entombed in it. These fossils consisting of the skeletal remains of all the groups of sea animals living at the time have been obtained from various levels marking different epochs of time and have been identified, and their biological relations worked out by a number of noted specialists since 1870.

A GEOGRAPHICAL ANTITHESIS

To this area, of extreme geological youth and immaturity, Ceylon offers a most striking geographical antithesis—as striking as any two contiguous areas of earth's surface can possibly offer. Their differences are fundamental. Ceylon represents a type of the earth's crust composed of extremely ancient crystalline and metamorphic rocks, which are the foundations on which the geological framework of other parts of the earth is built. For untold ages of time, it has remained an inflexible land-mass, a segment of a continental shield that has, since the Cambrian, the beginning of the Palaeozoic era, not been submerged underneath the sea nor subjected to earth's movements of the mountain-building type. All these characters it shares with the Deccan peninsula of India—a crust block revealing a fundamentally different type of earth architecture from that shown by the North Indian highlands, which are built of much younger sedimentary rocks that have been repeatedly submerged under and elevated from the floor of the ocean. Ceylon is a lately detached fragment

of this South Indian peninsula, possessing a common geological structure, composition, a plan of architecture, a fact which modern geological investigations tend more and more to emphasise. This feature of extreme antiquity of its rock-formation, Ceylon shares with a few other areas of the earth also, viz.: Canada; parts of Siberia and Mongolia and Central Africa-areas that have stood upon a firm and incompressible base, and have remained impassive for ages. Amidst all the revolutions of geography that have again and again changed the face of the world by redistribution of seas and lands, these areas have remained more or less impassive and inert, being only subject to one kind of vertical up and down movement. In the decay and renovation of mountains and plateaus these lands have had their share only through the passive role of generally sinking blocks with occasional upwarps of smaller constituent units.

DISTINGUISHING CHARACTERISTICS OF ANCIENT LAND AREAS

Several strongly marked features characterise these crust-blocks of which Ceylon, with the mainland of the Deccan, is a type, and which must be considered as important features in their geographical evolution. In the making of Ceylon, these have played a fundamental role, and we might roughly examine them:—

(1) The most prominent of these is the absence from the mainland of stratified deposits belonging to large sections of the geological record; except from the coastal margin—all those marine stratified formations, representative of the different geological systems from the Palaeozoic to the Cainozoic, which make up the geological history of a land-area are absent. The geological record of these land-masses is thus very meagre and confined to the very earliest periods of earth's history. The Archaean and Pre-Cambrian systems, with their granite masses pushed up from the interior of the earth, build the fundamental complex of rocks, which monotonously occupy hundreds and thousands of square miles of surface extent. Representatives of any of the younger rock-formations, when present, are wholly of the continental type of deposits, laid down by the agency of rivers in lake basins, or in faulted sunken troughs. The best example of the land-derived formations is the great Gondwana system of India, Africa and Australia—a vast pile of river and lake sediments

preserved in chains of faulted basins, carrying the important coal deposits of these countries. Fossil life-record preserved in these systems is not so full and illustrative as in the corresponding marine systems and is confined to only the land vegetation and animals. On the whole, the geological record preserved in these land-areas of the globe is extremely fragmentary and imperfect.

(2) The second chief characteristic of land-areas of the Ceylon type is the enormous waste they have been subjected to; there is in them universal evidence of wide-spread and deep erosion in which all the geographical features of the country are worn down and more or less levelled to their roots, leaving merely the stumps of mountain chains and plateaus supported on more or less level plains (peneplains). Several miles depth of rocks are thus stripped off the original land surface. A notable feature of these lands is that the mountains that are seen in them are not true mountains of uplift, i.e., those with a definite axis of elevation corresponding with the line of extension of the range, but the so-called mountains are merely relicts, undenuded portions, of the old plateaus that have escaped the weathering of ages that have cut away the surrounding parts of the land leaving some blocks of harder ground. These peneplains are subject to only one kind of earth-movement—vertical, up-and-down sliding of the crust, whereby they are capable of block uplift or downwarp. This tensional, as opposed to compressional, mountain-building, movement renews again and again the cycle of erosion of the peneplaned lands by the rejuvenating of their rivers and streams by the disorganisation of the previous hydrography and disturbing of the relative levels. Water-falls thus are a feature of such areas.

(3) A third characteristic of the ancient lands is the presence of certain types of minerals and rocks with their associated economic products, and by the absence or rarity of others. Crystalline ores of the heavy metals, rare-earth minerals, dense minerals with a compact molecular packing, e.g., garnet and corundum, sillimanite, ilmenite, radio-active compounds of thorium and uranium, and a host of crystallised transparent minerals (gems and precious stones) are relatively more abundantly distributed in the ancient crystalline rocks constituting these land-masses of the Ceylon type. On the other hand, deposits such as petroleum, natural gas, coal measures (except in local fault-basins of Gondwana type), lime-stones, shales, conglomerates, rock-salt, gypsum, etc., are rare, if not absent altogether.

(4) These land masses having experienced no recent folding (or compressional) movements possess geological structures of great stability which are in perfect equilibrium with their surroundings and are thus not subject to earthquakes of any intensity. The prominent seismic zone, the belt of the most destructive earthquakes of history traverses the earth along the recently compressed and upheaved belts of the world, such as the Alpine-Caucasian-Himalayan-Malay arc of mountains.

II

THE GEOGRAPHICAL EVOLUTION OF CEYLON

The geological history of Ceylon may be summarised in a sentence as the history of the very first chapter, rather fully recorded, and a fragmentary record of the last chapter of the geological history of the earth. The rest of the chapters forming the bulk of that history are a total blank, except for a few obliterated lines belonging to a page or two relating the events of an enthrallingly interesting period during the Mesozoic. These few lines are the much mutilated remains of the pages relating to events of the time when Ceylon formed part of the large Indo-African-Australian continent of the southern hemisphere, when the Himalayas were yet in the making and lying under the waters of the mediterranean ocean. For untold ages, even the skeletal outlines of India, with which till almost geologically recent times Ceylon was united, cannot be discerned. The first positive indication we obtain is that about the close of the Palaeozoic era, the three great peninsulas of the southern world were united in one continuous land-mass known in geology as Gondwanaland and that its climate was like that of the Antarctic circle to day, supporting gigantic snow-fields and glaciers in Africa, India and Australia. Its northern shores were bordered by a great ocean almost encircling the world, which is known in geology as *Tethys*, and of which the present Mediterranean Sea is the last surviving shrunken remnant. It was in the *Tethys* that the materials which form the present Himalayas, the Caucasus and the Alps, were laid down.

CEYLON: A PART OF THE GONDWANA CONTINENT

The story of the Gondwanaland is one of the epics of geological history. The probable extent and

the boundaries of this vast Southern Continent, its main drainage basins, the vicissitudes of its climate, the life that peopled its forests and rivers and the succession of its floras and faunas, the generations of forest growth, which survive in the highly productive coal-measures of today, all these are well-recorded in the rock-beds of the Gondwana system. After the Arctic cold of the glacial epoch, the climate became warm enough to support luxuriant vegetation, as is testified by the presence of coal seams, in the strata directly overlying the glacier boulder-beds in the Damuda series of India, the Murree series of Australia and the Karoo series of South Africa. The climatic pendulum then seems to have oscillated back to a cold climate, followed again by a warm epoch, in which desertic or semi-desertic conditions prevailed. It was during the latter part of the Gondwana period (Jurassic) that Ceylon received in a few narrow basins the river sediments from Central Gondwanalands. Of these, one solitary tiny patch of Upper Gondwana rocks found near Tabbowa, 35 miles west-south-west of Anuradhapura, is the sole memorial Ceylon possesses of its once having formed part of the body of the Great Gondwana Continent. Unfortunately this outcrop, which was small to begin with, has been further constricted by a series of step faults which has cut it up and thrown it down into the crystalline archaean as a much-squeezed and faulted strip of about two miles width, some 8 miles east of Puttalam. The deformation of the Tabbowa series is a memorable event of high significance. It gives the date of much the most important event on the geological history of Ceylon—the final upwarp of the Central Ceylon *massif* and fixes it as definitely post-Jurassic.

BREAKING UP OF THE GONDWANA CONTINENT

The dismemberment of the Gondwana Continent is believed to have taken place at the end of the Mesozoic era of earth-history or at the beginning of Cainozoic or Tertiary era. There has been considerable amount of controversy among geologists as to the *modus operandi* of this event. According to one view, the Continent was severed into its three principal units Africa, India and Australia by the foundering of two of the fault-blocks to form the present Arabian Sea and the Bay of Bengal. This view, which has a considerable body of geological and biological evidence to support it, was the prevailing and generally accepted view till Wegener

promulgated his Continental drift theory. This hypothesis postulates that the vast original agglomeration of the continents of the world (the *pangea*), into one unit, during the late Palaeozoic and early Mesozoic, split up gradually into a number of units which finally separated from one another by slowly drifting away across the intervening semi-plastic sub-crust from the centre. This hypothesis also claims a number of adherents.

of volcanic activity, in the Deccan which has given rise to a lava-built plateau composed of horizontally bedded lava-floors, four to five thousand feet in height, and over 10 times the surface extent of Ceylon, and (2) the commencement of the series of upheavals which culminated in the elevation of the Himalayas, a chain of elevations 1,500 miles in length and 150 to 250 miles in breadth, with a mean altitude of 20,000 feet in the central axial range.

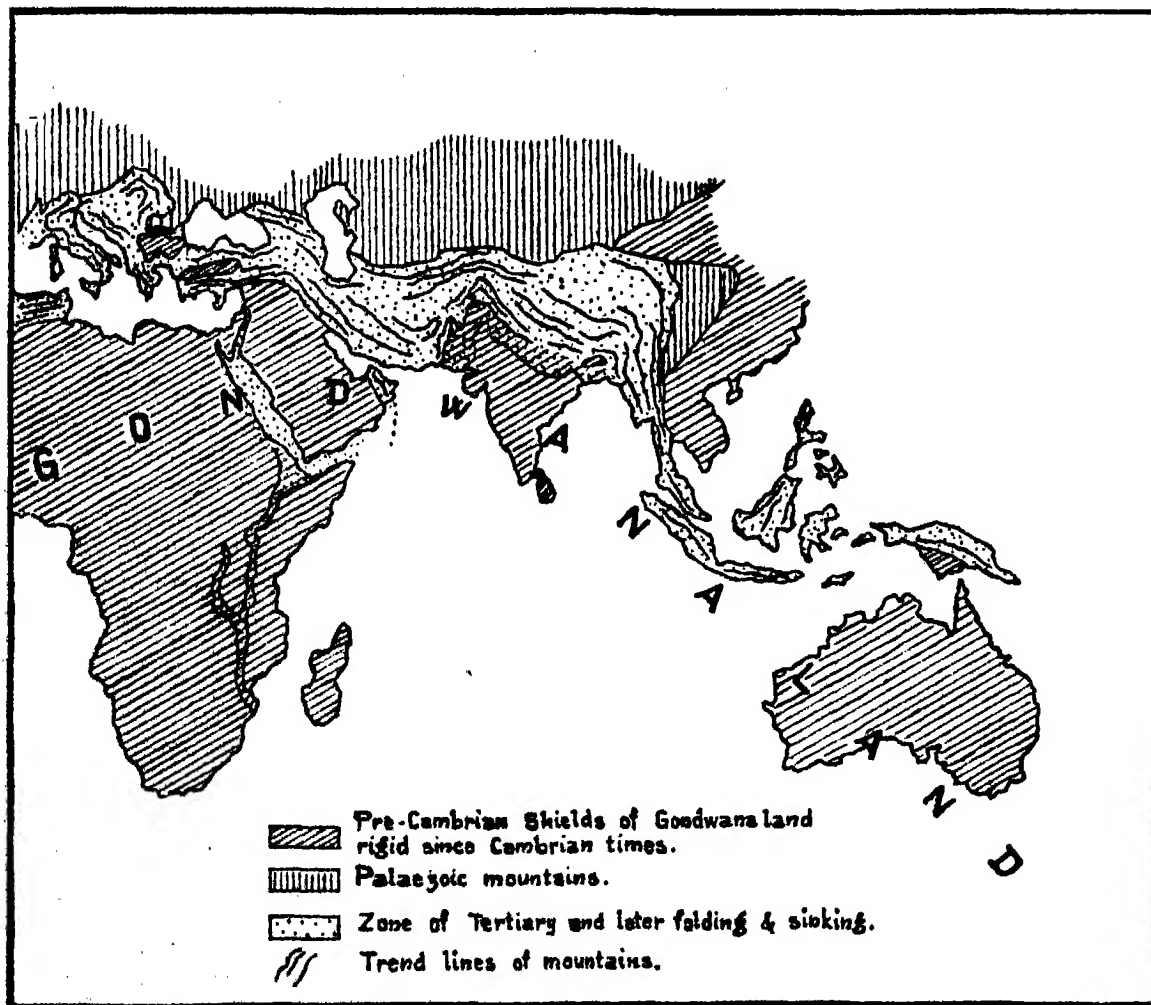


FIG. I.

The sketch illustrates in a generalised way the different types of crust-blocks of the earth—(1) Rigid shields of ancient land-masses with (2) their sunken bells and (3) the flexible zone composed of folded mountain-chains which have been uplifted from the oceans in Tertiary times. The Gondwana Continent, once a continuous land-mass, now dismembered and the severed parts are now separated by the ocean.

The severing of the Gondwana Continent at the end of the Mesozoic was coeval with two other great geographical revolutions, both of which, however, have left no mark on Ceylon: (1) A gigantic outburst

It was in the middle of the Cainozoic era that the outline of India was for the first time defined and it acquired its present configuration. Ceylon was still now an integral part of the Deccan peninsula, and

its history during the long vista of geological time is the history of the Deccan. It is only since the Miocene epoch that Ceylon became a separate geographical entity and began to pursue its own course of evolution. A wide and deep arm of the Miocene sea, much wider and deeper than the Palk Strait of to day, flooded the mainland between Madras and Puttalam, severing the south-east extremity of the peninsula and converting it into a continental island. This submarine depression is recorded in the thick limestone deposits of the Jaffna series and in the Karikal and Warkali beds of South India. But this severance did not last long and ever since the close of the Miocene, there has been a persistent but slow upward movement of the sea-bottom, whereby hundreds of feet of limestone and related strata, formed on the floor of that sea, are to day exposed sub-aerially between Jaffna and Puttalam. The shallowing of the sea is most marked between the north-west coast of Ceylon and a NNE—SSW line connecting Pondicherry and Cape Comorin. Here the sea is barely 15 fathoms deep, whereas it deepens rapidly to 1,000—2,000 fathoms on the sea coast off Matara and Trincomalee.

Except for minor oscillations of the level of the sea and land, few geographical changes of any note have occurred in Ceylon since the Miocene.

WASTE OF CEYLON'S HIGHLANDS

From the foregoing account, it must be apparent that in the making of Ceylon, the geological processes that have been most operative through a vast section of geological time are not the building processes but the destructive agencies of nature. The tale of waste of the land-mass is writ large in the geology of Ceylon. Since the commencement of the Palaeozoic, but few or no rock-deposits have been formed and added to the primitive ground complex of Archaean age, but a ceaseless process of sub-aerial decay and erosion through the atmospheric agencies has taken place, which has on a conservative estimate, removed from the original surface of the country over 10,000 feet depth of rock. The beautiful terraced structure

of the island in three well-marked tiers, or terraces, superposed on a wide submarine plain, so clearly visible from Haputale-Haldummulla road, is the central fact in the physiography of Ceylon. It shows how the island has been a positive element of the earth's crust and has received a persistent uplift from the ocean-bed *pari passu* with the lowering of its surface by denudation. This uplift has not been a continuous one but has taken place in intermittent stages, and this periodic uplift has been instrumental in arresting the erosive forces from complete planation of the country down to the base level. The three peneplains are fronted by steep escarpments, hundreds if not thousands of feet high. There are unfortunately not many stratigraphic marks to date these various movements, but the last and lowest plane was presumably well-advanced towards gradation during the Jurassic period to receive on its flood-plain surface the detritus of a Gondwana river, scarcely 8 miles from the future Miocene sea-coast of Puttalam.

The erosion of the land-masses of Ceylon, however, is not unattended by economic consequences of direct benefit to Ceylon. The disintegration of 10,000 feet of the Archaean crystalline massif referred to above has liberated in a concentrated form economically valuable minerals and compounds which were before locked up in an extremely disseminated state in a vast bulk of barren rock. Thus are to be accounted for the Ratnapura gem-fields, the Pulmoddai and Batticaloa ilmenite beaches, the Induruwa monazite, the enormous stretches of pure quartz sands on the coasts. The produce of one gem-field represents the breaking up and erosion of million upon millions of tons of gneiss and granite rock by the atmospheric agents; these dense transparent crystalline minerals (gems), by reason of their superior hardness and greater resistance to decomposition have been dropped by the rivers at their debouchures from the mountains, while the less dense, softer detritus has been carried away further as sands, clays and silt by the rivers and ultimately discharged at their journey's end into the sea,—land's tribute to the ocean since the beginning of time.

The Fisheries Departments of the Philippines and Malaya

With Comments on the needs of Bengal and India

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THE first men lived on forest products, together with such animal life, eggs, and the like as they were able to find or capture. Even to-day one may see in some places, as in the Sulu Islands (Philippines) and elsewhere, troops of monkeys leaving the trees and going out on the sea beach at low tide to make a meal of various sea animals, small fish, Mollusca, Crustacea, and worms. We may be certain, therefore, that primitive man from the earliest times caught and ate fish, crabs and their like, and all sorts of Mollusca occurring between high and low tide marks. Fisheries are, therefore, almost coeval with the utilization of forest products.

The four primary sources of wealth in any country are, in the order of their development, forests, fisheries, agriculture, and mining. Agriculture was not developed for a very long time after the first two, and mining came still later. In all ages and in all climes fisheries have been of importance. Wherever man has lived by the sea, lakes, or rivers he has found in their waters one of his most important foods. Since fish cost nothing to rear or maintain, often came in fabulous numbers with the regularity of the seasons, were easy to catch and preserve for future use, dependence upon and development of fisheries came at an early stage of economic development.

In the rice-eating countries of eastern and south-eastern Asia, and the adjacent, great islands, the fisheries have always been of peculiar importance, since the mass of the people prefer fish to any other form of animal protein. In all the above regions the

methods now in use were developed a very long time ago and have been handed down to the present time with very little change. These methods were efficient enough in former times when the population was small, but with the great and rapidly accelerating increase in population to-day they are far from meeting the needs of the people. To get the fishermen of those regions to change their methods and use boats and fishing gear different from the ancient ancestral types is a very difficult task. This is due to a number of causes, the chief ones being ignorance, conceit, poverty, and lack of co-operation. None are more tenacious of tradition or harder to convert to new ways than the ignorant, and none are more positive that they know it all. This is eminently true of the Oriental fisherman.

FISHERIES IN THE PHILIPPINES

In spite of the manifold difficulties impeding progress, real improvement is gradually being effected in the Philippines.* When I assumed charge of Philippine fisheries, there was not a single Filipino trained in the scientific study of fishes or in modern methods of fishing and fish preservation. To-day there is a staff of Filipinos, some of whom have demonstrated exceptional ability, who have been trained in the United States and Japan in such lines as ichthyology, fish culture, hatchery management, fishery methods, canning, drying, refrigeration, oyster culture, etc. It is self-evident that the formation of a corps of adequately trained scientific staff is the first step towards the modernization and proper development of a country's fisheries.

* Summary of a talk given at the Royal Asiatic Society of Bengal on December 2, 1940.

* The writer was formerly chief of the division of fisheries, Bureau of Science, Manila, Philippines.

From India to Malaya and on throughout the East Indies, from which the Philippines cannot be separated geographically, the boats used by the native fishermen are keelless canoes or catamarans, without cargo space and utterly unsuited for off-shore fishing or for fishing by modern methods. Their working radius is limited to a few miles. Likewise their nets have a mesh entirely too small, so that they cannot be handled with rapidity and efficiency.

It is now more than 22 years since Japanese fishermen, using the *muro-ami* method and power launches, began operations in the Philippines and East Indies. For several years I aided them in several ways, thinking that when the Filipino fishermen saw how the Japanese fishermen prospered, at least some would adopt the new methods and profit thereby. In a few years Japanese fishermen were at work throughout the Philippines and East Indies and were very important factors in supplying the markets of Manila, Singapore, Batavia, and other large cities of the island world off south-eastern Asia. They went to remote isles and reefs, returning with iced cargoes of fish that were rarely or not at all taken by the native fishermen. Ordinary storms and rough weather did not stop them, as their keel-built launches with powerful engines could either outride them or easily make for some sheltered inlet or bay. At the same time the common people benefitted by being supplied with an abundance of wholesome edible fish at moderate prices. Yet the native fishermen did not follow the lead of the Japanese, but adhered to their old ways. Thus the Japanese gained an ever greater ascendancy in the fisheries.

The reasons for the supremacy of Japanese fishermen over those of other Asiatic countries are plainly in evidence. It begins with village schools, the Japanese being the only people with a definite system of education specifically planned for fishermen's sons. The boys of a fishing village attend a primary school where they are taught the fundamentals of fishing, in accordance with the findings of their scientific experts. They are instructed in the making and use of fishing gear and all sorts of tackle, in the making and handling of boats, in the best methods of taking various kinds of fishes, in short, in the basic principles of the art of fishing. In each maritime prefecture there is also at least one secondary school, where boys receive more advanced training. They go more deeply into the construction of boats and tackle of all sorts, and their proper use. They learn the rudiments of navigation, and study

the chief commercial fishes and their proper utilization. When they graduate they are ready to become captains of fishing craft or to hold subordinate industrial posts in the fishing industry. Lastly, there is the Imperial Fisheries Institute, which is a department of the University of Tokyo. Here scientific and technical experts are trained for research, administration, and industrial work upon everything that concerns fish, fish handling, and fish preservation. In addition to the admirable educational facilities provided, every prefecture has at least one experimental station for work on fishes and fisheries. Each station on the sea coast has at least one ship or ocean-going launch, to carry on research at sea. Formosa alone had seven such ships, fifteen years ago, constantly engaged in fisheries research. The Japanese Government encourages and supports the fishing industry in every possible way.

There is a tuna cannery at Zamboanga, operated by Japanese, who are supposed to train Filipinos to catch and process tuna, but thus far no real training has been given. Fishery experts were to be imported for that purpose, but thus far that has not been done. Ordinary Japanese fishermen, without qualifications for teaching, have been called experts, but have failed to teach anything worth while to Filipino student fishermen, who have learned nothing enabling them to carry on independently, either as fishermen or as cannery operators.

The principal activities of the Philippine fisheries department are grouped about sea fisheries, with special emphasis upon the sardine industry; the pond culture of marine fishes; the pond culture of freshwater fishes; lake and river fisheries; culture of edible oysters and other molluscs; the study of pearl oysters and button shell molluscs; experimental study of shrimp and other Crustacea; experimental fish canning, and other methods of fish preservation. These activities are not concentrated in any one locality, but are scattered over the islands in the places deemed most suitable for such work.

Nearly ten crores of rupees are invested in salt water fish ponds in the Philippines, mainly about Manila Bay, for the culture of *Chanos chanos*. This fish is the *Tullu cāndal* of Tamil and *Pāla bontah* of Telugu. Although Philippine methods are superior to those in use elsewhere, there is room for improvement. An experiment station is devoted entirely to the culture of this fish, in an effort to work out scientific methods to replace the traditional rule-of-thumb practices.

Gurami, a Javanese freshwater fish of superior quality, was introduced by the writer and is now cultivated in three-fourths of the provinces. It is very extensively bred now in the lowlands, and bids fair to do for the Philippines what it has done for over-populated Java where it furnishes a plentiful supply of fish in regions away from the sea. In addition to gurami, other kinds of freshwater fishes are being bred to ascertain their suitability under Philippine conditions.

The fisheries division is headed by a specially trained zoologist, a Filipino familiar with conditions in his own country and the fisheries of the western coast of America and Japan. He is able to lead and advise his staff in scientific problems, so that the prospects are good for a better development and more scientific management of Philippine fisheries than ever before.

WORK IN MALAYA

In the Straits Settlements and Federated Malay States the fisheries were formerly conducted by Malay and Chinese fishermen. When Japanese came with motor launches they speedily assumed a dominant position in the Singapore market. Unlike the Malays and Chinese, whose canoes and junks had a very limited range of movement, the Japanese could go great distances and catch fish in quantity wherever they went. From Singapore they not only worked both the east and west coasts of Malaya, but went north to the Gulf of Siam, eastward through the shoals and reefs of the South China Sea, and all along the coast of Borneo. They fished the adjacent coasts of Sumatra, the islands south of Singapore, the reefs of the Java Sea, the Flores Sea, the isles of the Banda Sea, and even went as far east as the Aru Islands, south of New Guinea. No wonder Singapore received a vast supply of fish at relatively low prices.

At present the activities of Japanese fishermen about Singapore are greatly curtailed. The war conditions have hampered them, financially and otherwise, while the licences of all those infringing upon or disregarding regulations have not been renewed. The number now operating is, therefore, not much more than a third of those active a few years ago.

The fisheries department of the Straits Settlements and Federated Malay States is working actively towards the betterment of both marine and freshwater fisheries. Particular attention is being paid to the culture of the larger native freshwater fishes.

At the Tapah Experiment Station in Perak the culture of various native carps, as well as that of gurami and some other fishes, is being carefully studied. Already the influence of this station is evident among the local Malays, many of whom are taking up fish culture.

In the Cameron Highlands, Pahang, a trout hatchery has been established and a number of streams have been stocked, so that sportsmen may now angle for trout. The hatching of trout in the tropics, and the stocking of a few remote mountain brooks, is a very expensive matter, and has little justification. It is done in response to the efforts of a very minute but vociferous fraction of the population, and its expense is out of all proportion to the number of people benefitted. The establishment and artificial maintenance of trout fisheries in the tropics is something that should come after everything else possible has been done to maintain and augment the supply of food fishes for the common people.

The native fishermen of Malaya are just as ignorant and averse to change as those of the Philippines, while their methods are more backward. The fisheries department is headed by competent and thoroughly trained biologists, who are doing all they can to rectify conditions. In spite of all they can do it will take a long time to work any appreciable change in the marine fisheries. However, in Malaya, and to a much greater extent in the Philippines, the foundation has been laid for a development of aquatic resources far beyond anything in the past. Rational and sound conservation methods for both marine and freshwater fishes are being introduced as rapidly as knowledge is gained and conditions allow of their acceptance.

CONDITIONS IN BENGAL

How do the preceding conditions compare with those in Bengal, and what is the status of Bengal fisheries? As you all know, there is no fisheries department in Bengal, and the status of Bengal fisheries is deplorable. The huge, sprawling city of Calcutta, with its swarms of poor and half-fed people, is very inadequately supplied with fish, and this is true likewise of very many of the towns and villages of Bengal. A comparison of the markets of Calcutta with those of Hong Kong or Manila,—cities perhaps a third of the size of Calcutta,—affords ample proof of the truth of my statement.

After making all due allowance for the vegetarians, and the people who refuse to eat fish, there remains in Bengal a vast number of people who are glad to eat fish, but at the same time rarely have enough to eat. They are not only victims of semistarvation, but also suffer from malnutrition, as a result of living on a diet deficient in protein. The addition of an adequate supply of fish to their diet would furnish them with the nutritious, wholesome, and readily assimilable protein necessary to balance their diet and build tissue.

At present the people of Bengal and adjacent provinces prefer freshwater fishes to those exclusively marine, as any one can see who studies the local markets. This is due to a variety of causes, not the least of which are the inadequacy of the transportation and preservation of fresh fish. Before there can be any real development of fisheries, especially of sea fisheries, there must be suitable provision made for the proper distribution and marketing of the fish obtained. These require an ample supply of cheap ice, and ample cold storage facilities. The logical agency to supply such need is, of course, the government itself. There is no great public service rendered if the catch is brought in half-putrid, or even merely stale, condition and then left to haphazard agencies to get it in the hands of the consuming public. Experience elsewhere has shown that ultimately government cold storage and ice plants are absorbed by private interests, although in the beginning private capital could not be interested.

There are many things a Bengal fisheries department might suitably do, and many problems it might profitably investigate. However, there are certain obvious needs which are most closely linked with the improvement of the food supply of the common people, and it is those to which a fisheries department should devote most of its energies. All studies and surveys should be planned to cover a term of years, and should be continued until definite results were reached, or it was positively shown that they were futile. (1) A study of the freshwater river and tank fishes. This should include their distribution, breeding habits, food, rate of growth, migrations (if any) and all other details of their life history, their enemies, diseases, and all factors affecting them adversely or favourably. (2) Similar studies should be conducted upon the estuarine fishes characteristic of the brackish water creeks and channels, especially in the Ganges Delta. (3) Experimental studies upon the pond culture of (a) native freshwater fishes ;

and (b) of freshwater fishes from other countries. (4) Experimental ponds for the culture of various marine and brackish water fishes, especially *Chanos chanos*. (5) A study of the distribution, seasonal occurrence, food, and life histories of marine shore fishes, together with a study of the fishery methods for each kind. Linked with this would be (6) improved methods of drying, salting, introduction of canning, etc., and (7) methods of handling fresh fish by icing, brine-freezing, refrigeration, etc. (8) A survey of the very rich fish fauna of the Andaman Islands. The development of Andaman fisheries by the use of *muro-ami* nets, gill nets, trammel nets, drift nets, fish corrals, long-line fishing, hand-line fishing, and commercial angling, would afford a large supply of high quality food fishes in great variety. They could easily be landed cheaply at Calcutta, in first class condition. (9) Experimental work on the culture of shrimps or prawns. (10) Continuation of work on trout and other fishes from cold climates, already introduced into mountain streams. (11) Experimental work on oysters and other Mollusca. (12) A careful survey of the Bay of Bengal, with a view to developing its deep sea and pelagic fisheries. Trawling, and perhaps drift nets, longline fishing, and commercial angling might all be used with success. Since there is nothing in the way of native pelagic or deep sea fishing, in India, such development would be a difficult matter and must be left for the future.

The list could be much extended ; for example, there is a great field in the utilization of by-products, particularly in connection with pelagic and deep sea fishing, where the livers of certain species have proved to be very valuable in recent years. There is also a great deal to be done in gaining more knowledge about larvicidal fishes, and their value in improving health conditions. Enough has been indicated above to keep a department of fisheries busy for a very long time. It must always be borne in mind that a fisheries department cannot work miracles, or get beneficent results in a year or two. The methods of one region may not be at all workable in another region. Only general principles can be gained by study in England or the United States, since the fishes of India do not occur in Europe or America, while the climatic differences compel great differences in the handling and preservation of fishes. The actual details of operation must be worked out on the ground by properly trained biologists and chemists working in co-operation.

ORGANISATION OF THE FISHERIES DEPARTMENT

It is evident that there is need for a fisheries department in Bengal, so that it is in order to say something about the kind of a department it should be, and something of its staff.

Needless to say, it should be entirely outside politics, and politicians should have nothing to say about appointments to its staff. Only one thing should be considered in making an appointment,—thoroughly trained efficiency. The director should be not only a highly trained biologist, with specialized knowledge of fishes, or fish culture, and fisheries, but he should also be a dreamer, with the energy to activate his dreams. In the long run it is only the dreamer and seer of visions who gets things worth while done. He alone can visualize other ways of doing things, or see them differently from the way they are now done. He should have vision enough to plan a consistent scientific programme for ten years or twenty-five years in advance, and have experience enough to make his plan workable. He should have authority to amend, amplify, or otherwise adapt his programme to changing conditions, to meet public prejudices, and other deterrents of unforeseen character. He should likewise have a free hand in the selection of his staff, so that he may secure the best trained men possible, without regard to race, religion, social status, or political views.

To place a glorified clerk or "administrator" in charge of a bureau of fisheries is unthinkable, and puts a strain on the department that makes it creak in the joints. A lack of definite, specific knowledge on the part of the director makes him peculiarly liable to espouse erratic or unworkable projects, and to take up expensive and unsuitable schemes, the fallacy of which may have been demonstrated over and over again elsewhere. A clerk is not placed in charge of a campaign against the bubonic plague, or in command of an ocean liner. Neither should he be in control of a scientific bureau, trying to handle problems of which he knows nothing and of which he can form no adequate concept.

At this point attention may be directed to the fact that India has very few men qualified by training and experience to do work with fishes. The Zoological Survey has several competent biologists on its staff, including one eminent ichthyologist who has specialized on freshwater fishes. But this is not enough. It is true there are no jobs waiting to be filled at present, but it is time that some of the

Indian colleges and universities wakened to the paucity of workers on Indian fishes, and that some departments of zoology began to train students to work on fishes and fishery problems. It is better to have trained workers without jobs than to wait until there are vacancies to fill before starting to train workers.

The idea has been advanced that a department of fisheries should pay its own way, or even make a profit. Such an idea is unsound anywhere, and is especially erroneous in Bengal, where the fisheries are undeveloped and the industry is not only unorganized but needs to be carefully nurtured if it is ever to amount to anything. It cannot be too greatly emphasized that the primary function of a fisheries department is to maintain, and conserve, and if possible to improve and increase the food supply of the mass of the people. All other considerations are subordinate. There is no more reason to expect a fisheries department to pay its way than to expect the bureau of health to make large profits out of epidemics, or the fire department to gain lakhs of rupees from fires. No one expects the department of agriculture to conduct large grain farms and maintain large herds of cattle for profit; neither should a fisheries department engage in commercial fishing. The fisheries department may educate the fishermen and general public, and show what is to be done and how to do it, by experimental work and demonstration, but beyond that it should not go. If any direct revenue is obtained by the sale of angler's licences, from the registration and licensing of commercial fishermen and their craft, and the licensing of various sorts of fishing gear, it is incidental and is not the true purpose for which a department is maintained.

On the other hand the government ultimately derives a large amount of revenue as the result of having a strong fisheries department. The growth of various phases of fishing, with its attendant increase of invested capital in boats, ships, fishing gear, etc., the development of fish ponds, of drying, salting, and canning establishments, the manufacture of by-products such as oils rich in certain vitamins, and the development of and the exploration of other potentialities would, in the aggregate, increase the amount and value of taxable property to such an extent as to repay the cost of a fisheries department manifold.

At the same time it is well to note that if a fisheries department increases the food supply of the people and thereby causes them to be better fed,

bringing them greater comfort, energy, and health, it has amply earned its right to exist, whether it ever earns any revenue or not.

Thus far only the needs of Bengal have been mentioned. What has been said applies with even more force to the need for a fisheries department for India. Politicians and provincials of inflated egoism may insist upon ancient puny political boundaries, but it is well to observe that the fish do not recognize them. Only too often a flourishing fishing industry has been destroyed because some man-made senseless boundary allowed greedy and reckless people to destroy fishes without giving them a chance to reproduce.

Madras has had a fisheries department for twenty-five years or so, and much valuable work has been done by it. Unfortunately it is at present admini-

stered by the Director of Industries, and has no director of its own. Naturally the Director of Industries thinks the fisheries department should be revenue producing, and research unnecessary. A fisheries department without emphasis upon research soon becomes moribund.

Bombay, Karachi, and Travancore are each making tentative efforts to develop a department of fisheries. There is ample room and work for a strong department of fisheries in each of the great subdivisions of India. At the same time there is equal need for a national department of fisheries to co-ordinate the efforts of the various presidencies and provinces, to look especially after migratory and pelagic fishes, the deep sea fishes, and the development of the fisheries of the Bay of Bengal and the Arabian Sea outside the provincial boundaries.

THIRD CYCLOTRON IN MOSCOW

The great fillip that has been given by cyclotron to the study of nuclear physics and of radioactive isotopes as applied to biology is shown by the progressive countries of the world in building very powerful cyclotrons. The Radium Institute of Leningrad has one cyclotron and the Leningrad Physico-Technical Institute, of which Prof. Joffe is director, is building another. It has now been announced that a third cyclotron, which will be able to produce 50 million electron volt deuterons, is going to be built in Moscow. It will have a magnet the core of which will weigh 1,000 tons and the solenoid 18 tons. An idea of the size and weight of the cyclotron can thus be obtained. The interest that the Soviet Government has been taking ever since its installation in power in all manners of scientific progress seems to be almost unparalleled in the history of the world. The way how they provided extraordinary facilities for the work of Prof. Kapitza will be fresh in many peoples' minds.

The Biochemistry of Cancer

B. ZBARSKY

RESARCHES in albuminous substances have been carried on for over a century, and, since the discovery that protein is essential for the maintenance of life, the interest shown in it from every aspect has greatly increased. Chemists have studied the various properties of proteins, their molecular weight and their structure. Physiologists have conducted long and patient researches to determine the exact quantity and quality of proteins required by man for his nourishment. Clinical medicine has found it useful for diagnosis to know the changes that take place in the properties of the proteins in the blood in disease. Research has produced valuable data on the physical and chemical properties of protein. From the standpoint of the biologist, however, all these studies are found to have an important defect. The materials employed were usually albuminous extracts, known as albumins, globulins, fibrin, casein, edesthine, gliadin, legumin, etc., obtained from animal and vegetable organisms. Various processes—the most common being salt precipitation—are applied to obtain these from organs and tissues, but during these processes the whole of the protein is not extracted. Albumins, globulins and the rest of these substances are merely fragments, artificially-detached parts of the complex molecule of the protein in the living tissue. That is why, from the biologist's point of view, the results of studies made with these extracted substances cannot be satisfactory. It is impossible, for instance, to judge of the properties and behaviour of the complex molecule of protein contained in the blood or the brain-cells from the properties of the albumins in the blood or the globulins in the brain-tissue. The study of the protein zein, obtained from maize, showed that zein was deficient in nourishment and it was inferred that the proteins in maize were inferior. After further researches it appeared that this conclusion was a mistaken one and that maize was an excellent full-value food. The error had occurred because zein, which is merely a part of the protein content of maize, had been identified with the total protein in that grain. A number of similar examples

led to the conclusion that for the study of biological problems it is necessary to know the properties of the entire protein content in the given tissue and not of detached fractions of protein.

Particular interest is being taken at present in researches in the amino-acid constituents of proteins. No one doubts, of course, that the complex molecule of protein consists of amino-acids connected with each other and it is upon this connection that chemists are concentrating their attention. The question is one of the greatest importance not only for the study of the structure of protein, but for biology as well. As a matter of fact, the proteins of every organ in one species of animal prove to have specific properties which differ from those of the same organs in another species. It may be conjectured that the immense variety of proteins in nature is accounted for by the dissimilarity of their amino-acid composition. From this standpoint, therefore, the determining of the amino-acid composition of the proteins of different organs and tissues is of the greatest interest, since it may also serve as a basis for explaining the various functions of separate parts of the organism.

Unfortunately, the study of the amino-acid content of proteins was carried on in exactly the same way—with albumins, globulins and other extracts. Their composition could not, of course, be taken as representative of that of the proteins in the living cells of the organs and tissues that were being examined.

About ten years ago we suggested that, in connection with certain biological problems, we should make a study of the protein in an organ as a whole and not in accidentally detached fragments. Taking as our standpoint the fact that the albumins and globulins are artificial products obtained as a result of special treatment of the proteins of the tissues, we decided that nothing but the study of the total protein in the cells could disclose the specific properties of the various proteins and their alteration in disease.

We began with the investigation of the amino-acid composition of the total protein in different human organs and tissues. In order to do this we had to extract the whole of the proteins in the blood, liver, heart, spleen, kidneys, etc., for only thus could we form an idea of the specific nature of their composition. The biochemistry departments of the First and Second Moscow Medical Institutes conducted researches extending over many years to determine the amino-acid composition of the total proteins in the human organs and tissues, and we are now able to add this definition to the existing morphological description of separate organs. Thus we have an extremely interesting chemical anatomy of the proteins of the human organs and tissues.

We have become convinced that the proteins of every organ possess an amino-acid composition peculiar to them alone. For example, those of the spleen contain the amino-acid cystine in greater quantities than those of other organs, while the proteins of the heart are distinguished from those of other organs by their high content of tryptophane. Another amino-acid, lysin, is found in the largest quantities in the proteins of the kidneys, the skin and the thyroid gland. Similar differences in the composition of the proteins of separate organs can be seen in other amino-acids.

These researches show that the total proteins of the different human organs and tissues have their own specific amino-acid composition. There is no doubt that one of the reasons for the functional difference in the various organs and tissues lies in the dissimilarity of the chemical structure of their proteins.

The topography of the chemical substances in the human body has only just begun to be worked out. Since protein is the principal chemical substance in the protoplasm it is obvious that the morphological development and functional activity of each organ depends to a certain extent on the properties and structure of the proteins it contains. Undoubtedly a knowledge of the amino-acid composition of the total proteins of the human organs and tissues will be of great value to morphologists and biologists. Particularly important is the extension of this kind of work in onto- and phylogenesis, since they form the basis for an understanding of the structural and functional data for evolutionary morphology and physiology. In this field the best work so far has been done by Kaplansky and his colleagues on the amino-acid composition of the total proteins of the human brain. The outstanding

peculiarities of the metabolism taking place in an organ can perhaps be accounted for to a certain extent by its amino-acid composition.

We decided to conduct, parallel to these researches, the study of the same proteins and organs in the pathological state. We started from the premise that the morphological and functional changes taking place in the organs of a patient suffering from a serious complaint are undoubtedly connected with the alteration of the chemical composition of protein, the most essential substance in the cells. In other words, we were prepared to find that the amino-acid composition, too, of the proteins in the various organs might prove to be other than in the normal healthy person.

With this end in view we began the study of the proteins in the organs of patients suffering from cancer.

When we had extracted the total proteins from liver, spleen, heart, stomach and other organs belonging to those who had died of cancer, we employed the same method as in the case of healthy organs, to determine the amino-acid composition of the proteins. We have now completed our researches on certain organs and, although work is still going on and can only be expected to yield final results in a year or two, it is possible even now to summarize them to a certain extent.

Our work has shown that if we compare the amino-acid composition of the proteins of the spleen in the normal person with those of the cancer-patient, we find that in the latter case there is twice as much of the amino-acid lysin, and, on the other hand, a marked decrease in two other amino-acids—tryptophane and histidine. The proteins of the spleen retain the other amino-acids in practically the same proportions in the case of cancer as in the normal person.

A similar picture is presented by the proteins of the heart, where, in the cancer patient, we found a very marked increase—84%—of cystine, a reduction of 48% of tryptophane and a considerable increase—68%—of arginine. In almost none of the organs of the cancer patients we examined did the amino-acid composition of their proteins correspond exactly to those of the normal. So far, the least change of all has been found in the proteins of the blood of cancer patients, where there was a reduction of 35% in only one amino-acid—lysin. These results are the more interesting since, morphologically speaking, no changes were found in the organs examined. They

were free from metastases, and, from the pathologico-anatomical standpoint, showed no other changes. Therefore, the chemical alterations we found evidently take place in the proteins at a much earlier stage, long before they are discovered by morphologists. When we examined the cells under the microscope they still appeared normal in structure, though chemically already different from normal.

It would be premature to make any definitions as to how far the changes discovered are specific and peculiar to cancer. On the contrary, we feel certain the same phenomenon might be observed in the case of other serious illness. A serious illness brought on by the diseased state of some particular organ, not only affects the system as a whole, and not only impairs the functioning of organs far removed from the affected one, but may also cause even sooner the impairment of the chemical composition of the proteins of other organs. Another question is whether in illness the changes may not take place in the same amino-acids, or be quantitatively unequal. It is possible that the marked increase of cystine, for example, found in the proteins of the heart in a cancer patient does not correspond to that in the case of tuberculosis. It may be that herein lies the specific nature of the changes in the proteins in certain illnesses and diseases.

Further research will supply the answer to this question. The field has been widened by the experiments made on animals. As is well known, it is comparatively easy to produce a cancerous tumour similar to those from which human patients suffer on rabbits and mice.

Results resembling those obtained in the case of cancer patients were yielded by experiments on animals. For example, changes taking place in the blood of rabbits suffering from cancer are identical to those in the proteins of people with the same disease.

In addition to the proteins of the organs and tissues we investigated those of the tumours themselves. The whole of the protein was extracted from the tumours removed by surgical operation and its composition analyzed.

It was found to contain a high proportion of arginine, considerably higher—from 13% to 14%—than the usual arginine content, which is about 9%, in other organs. Marked impairment of the balance of the tumour-proteins was observed with respect to lysin. In other words, the composition of the proteins of the tumours did not prove typical for the whole system.

The question naturally arises whether the changes discovered by us in the proteins of the organs may not prove, too, to be one of the stages in the pathogenesis of cancer. Since the aetiology and pathogenesis of cancer have remained so far unaccounted for, we have the right to suppose that an answer in the affirmative to our question is permissible. Only experiments on animals with cancer can clear up this extremely important point. Animals are infected with cancer and killed at various stages of the development of their tumours, and the amino-acid composition of the proteins of various organs then investigated. We hope by this method to determine the forces regulating the alterations in the composition of the proteins at different stages of the development of the tumour.

It is anticipated that our researches will serve to clear up certain points in the complex problem of cancer. Question as to why organs like the stomach are more frequently attacked by cancer, while the spleen rarely is, and why certain ages are susceptible to this disease, may perhaps be accounted for by the unequal composition of the proteins of the organs.

The great majority of scientists engaged in cancer researches are gradually coming to the conclusion that the basic factor in a malignant growth, responsible for the transformation of the healthy cell into the cancerous, lies in the cell itself. Certain changes in the cell produce the tumour. Some scientists, (Lewis, for example) hold that it is precisely the chemical changes in the protoplasm of the cells that result in the malignant growth.

The biochemistry of malignant growths is as yet in its infancy. The recent discovery by Kögl of the presence of an unnatural amino-acid—the dextro-rotatory glutaminic—in the albumin of tumours has attracted a great deal of attention. It leads us to suppose that the changes in the amino-acid composition of proteins in cancer cases play, too, a not inconsiderable part in the development of the disease.

The study of the composition of the proteins requires time and labour. Encouraged by the extremely interesting results already yielded by research in the biochemistry of cancer—the scourge that is responsible for the death of thousands every year—we feel certain that in collaboration with other scientists who have obtained successful results in the study and treatment of the disease, it will in time be possible to solve this very complicated problem.

Barnard Institute of Radiology

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A SHORT time ago the writer of this note was privileged to visit the Barnard Institute of Radiology in Madras. He was greatly impressed by the equipments of the Institute, its organisation and the great amount of relief it has brought to the suffering public. Bombay too has got a similar institute of its own recently started by the Tatas.

It is a pity that Calcutta which prides itself to be the second city of the British Empire, has nothing even half as great as any of these. The limited space at the disposal of the writer enables him only to attempt a very brief outline of the various departments and activities of this model institute which, he hopes, will convey a glimpse of what is being done in that province.

The Barnard Institute of Radiology was opened in 1934 by the Governor of Madras. The Institute has been named after its first director, Capt. T. W. Barnard who has since retired. The Institute forms a part of the Government General Hospital and stands within the same compound. It is at present under the direct control of Lt.-Col. G. McRobert, M.D., F.R.C.P. who is superintendent of both the Government General Hospital and the B. I. R.

The Barnard Institute of Radiology is a part of one big project as drawn up by Capt. T. W. Barnard. The original scheme was to start a Central Radiological Institute in Madras which would serve as a training centre for radiologists. A diploma in medical radiology was to be awarded to successful medical graduates and these would be sent to the district headquarters hospitals in the province, in each of which a small radiological department was to be added. A Radium Laboratory was to be attached to the Central Radiological Institute from which radon would be extracted and sent to the surgeons at the district headquarters. It was also hoped to form a Radium Therapy Research Committee on the

lines adopted by the British Medical Research Council.

It is gratifying to note that although a very short time has passed since this scheme was drawn up by Capt. Barnard, a great part of it has already materialised. The Central Radiological Institute has been started, the Radium Laboratory and the Radon Extraction Plant has been in operation since 1936. A diploma in medical radiology is granted by the Government of Madras after nine months' training in this Institute. The diploma course embraces all branches of medical radiology and electrology and also includes a short training in physics and electrical engineering as applied to X-ray tubes and h. f. discharges. In this respect the Institute has removed a long-felt need for the whole of India. Amongst the students for diploma course in medical radiology one meets with medical graduates not only from the province of Madras but from such distant places as Assam, Bengal, the Punjab and Coorg.

Of the 24 district headquarters hospitals in Madras, radiological departments have been added to 15 and radium treatment centres started in 5. At present the Institute has no special cancer ward of its own, but the original scheme provides for the building of a Cancer Hospital with about 100 beds. It has not yet been possible to start a Radium Therapy Research Council or to start any organised research work in cancer.

During the last year there were over 400 radium patients treated in the general hospital. Including those in the Gosha Hospital for women and children and those at the district hospitals, the number of patients treated by radium needles or radon seeds will be near about a thousand. It is a great pity that no permanent records or statistics of the cases could be kept as it has been found to be extremely difficult to be in touch with the old patients once

they are discharged from the hospital after treatment.

The Institute with its present equipments cost about 15 lakhs of rupees including 4 lakhs for the building and about 2 lakhs for 1'80 grammes of

large demonstration hall where D. M. R. classes are held are additional features of this section of the Institute.

Each pair of radiographic rooms has a dark room in common with connecting cupboards in the wall.

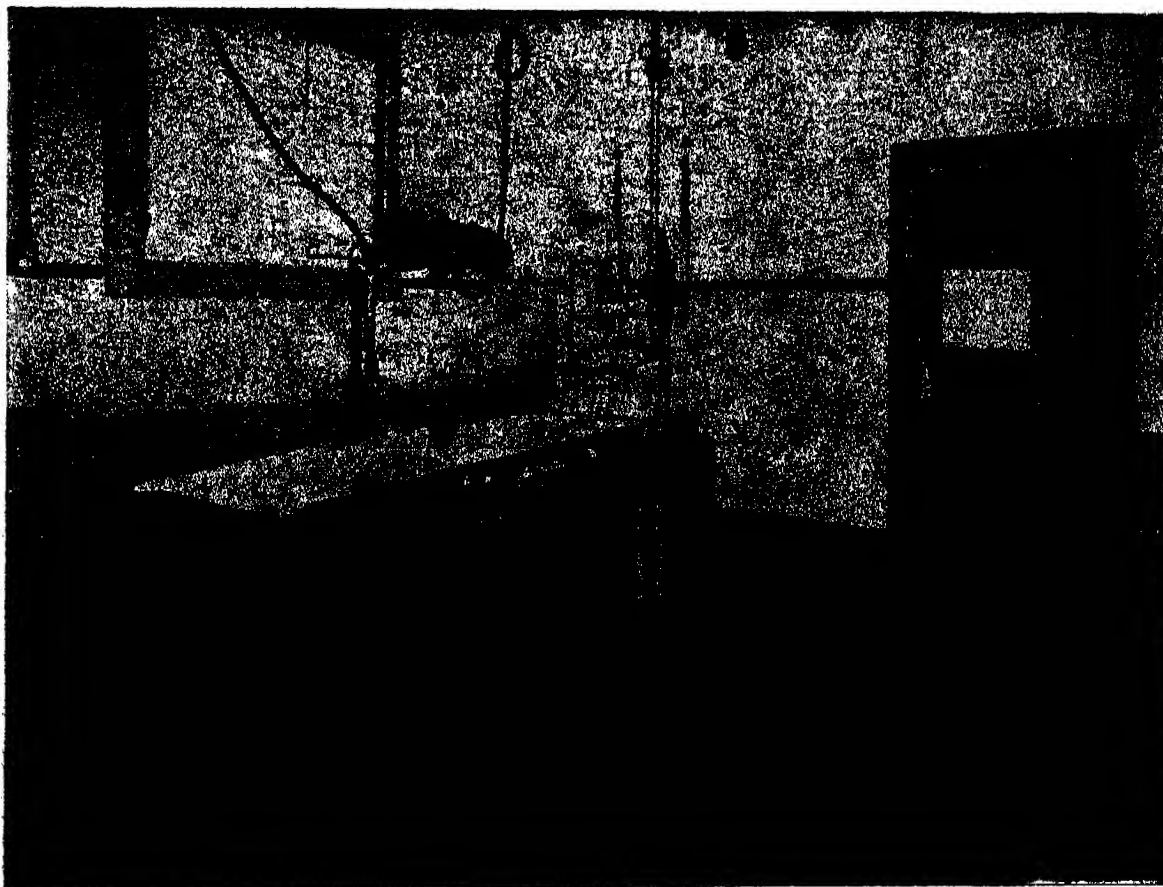


FIG. I. One of the Radiographic and Screening Rooms.

radium. It has about 75 rooms installed with various apparatuses. There are seven sets of X-ray treatment apparatus, one 400 kv. and two 200 kv. tubes for deep therapy and two 100 kv. tubes and two Chaoul tubes for superficial therapy. All the X-ray rooms have wooden floor and the apparatuses are controlled from outside the treatment rooms (operation corridor).

On the radiographic side there are six apparatuses including one Victor K. X. 5 apparatus with a stabiliser unit by means of which patients may be examined at two metres' distance. Dean's apparatus for upright and horizontal screening and radiography, a portable emergency X-ray unit, a dental X-ray department, an urological theatre and a

This is of revolving light-tight design which provides for easy transference of films from X-ray department to the dark room. The dark rooms are green tiled from the floor up to the ceiling. The dark rooms, the demonstration hall and the radiographic rooms are all air-conditioned. Two ammonia compressors furnish the required refrigeration for X-ray film developing and washing cabinets. The solutions in the cabinet are maintained at a fixed temperature of 65°F. The washing water is automatically changed five times every hour. Special thermostatic valves maintain the temperature of the solution within $\pm 1^\circ$ of the required temperature. The whole plant works absolutely automatically.

The radium section of the Institute has been housed on the first floor of the southern block. Both the radium section and the deep X-ray rooms face the river Cooum and the wide open military grounds which are not likely to be built upon in near future. Thus the possible dangers from the radiation have been minimised as much as possible. On the first floor of the southern block, there are the radium safe, radon laboratory, radium bomb apparatus, radium implantation theatre, the physicist's laboratory, dark room and a small workshop with lathe, carpenter's and metal worker's benches.

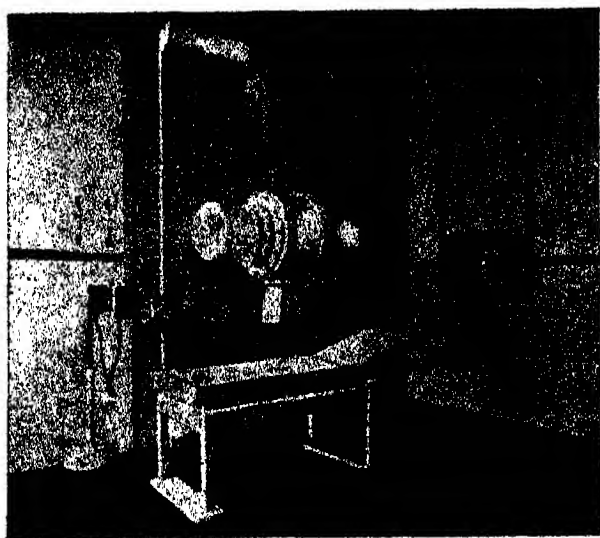


FIG. II. Deep X-Ray Therapy Unit.

On the opposite side of a spacious corridor which serves as a waiting room for the patients, there are six cubicles for ultra-violet radiation treatment and a large hall for general light treatment of children (children solarium). The floor of the solarium has been finished with tiles forming circles for the guidance of children during exposures.

The Institute has at present about 1'80 gms. of radium element. Of this about '80 gms. of radium are inside of platinum-iridium needles containing 1.5 mgms. each. These are used for the treatment of local cancer patients. The surgeons in charge of the wards in the General Hospital use radium needles from B. I. R. for the treatment of their own patients. These needles have to be returned to the Institute as soon as the patient has been given the required dose of exposure. On account of the price of the radium element and the risk of loss of small needles,

careful check has to be maintained constantly on the number of needles sent out of the radium safe and the number actually returned. One great disadvantage of having radium in needles is that they must needs be kept confined to the same place.

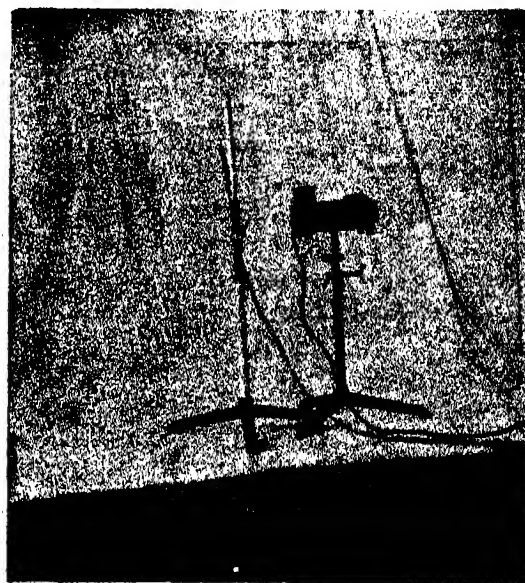


FIG. III. Dosimeter.

It is very risky to send them by post to district headquarters hospitals where radium may be urgently needed. On the other hand the advantage of radium needles arises from the fact that it gives a constant intense radiation and is therefore practically fool-proof as regards dosage etc. But often circumstances arise when patients cannot afford to come and stay in the General Hospital or to stay long in the hospital. In such cases the radium needles cannot be used as the maintenance of their adequate supervision is not possible. In all such cases, where the risk of loss outweighs the advantages of the constancy of radiation, the common practice in all the leading Radiological Institutes is to send applicators containing radon or the emanation from radium.

Radium is a member of a family of radioactive elements, each of which is changing at a constant rate into the next. Radium emits an α -particle and is converted to an inert gas radon which in turn decays to $RaA \rightarrow RaB \rightarrow RaC \rightarrow RaC' \rightarrow RaD \rightarrow RaE \rightarrow RaF$ etc. Both radium itself and its emanation (radon) are useless clinically because they do not emit any γ -rays themselves. These bodies owe their importance to the γ -rays given out by their descendant

RaC' , the fifth descendant from radium and the fourth from radon. If we have some amount of radium element sealed in needles, the radium atoms will disintegrate in course of time and form atoms of RaC' which emit penetrating γ -rays. One of the modern practices in radio-therapy is to keep the radium in solution secured in an iron safe from which the radon gas given out is drawn off by means of a mercury pump, purified and sealed in glass tubes which are then enclosed in gold or platinum needles so as to cut off α - and β -rays. These radon seeds can then be used in exactly the same way as the radium needles but with two distinct advantages. Little supervision is needed as the value of radon is practically nil. The seeds may be sent to distant places by post and the range of applicability is much widened. During treatment the patient need not be kept confined to the hospital and the seeds may even be left in the body of the patient as radon will lose all its radio-active properties during a month's time and become then quite harmless.

A semi-automatic radon plant has been in operation in this Institute since 1936, as devised by Failla of the New York Memorial Hospital. It was the second radon plant installed in the East, the only other plant being at Tokyo. For the last few months another radon plant of the same design has been in operation at the Tata Memorial Hospital, Bombay. In Madras, about 1 gm. of radium is in solution from which about 166 millicuries of radon may be collected each day. A diagram of the plant is given here, it works automatically after the pump is first started by the operator. The operator's presence is only needed for starting the pump and for sealing radon into small glass capillaries after it has been pumped into them. The small glass capillaries are put into hollow gold needles giving a filtration of about 6 mm.

The radon seeds are packed into small lead containers and sent by ordinary post to different radium treatment centres in the province. There are five at present, at Tanjore, Madura, Coimbatore,

Bellary and Guntur. Some of these centres are as much as 400 miles away from Madras so that radon seeds require about 24 hours to reach their destination. During this time radon decays by 17% so that if 80 millicuries were sent out on the previous day its strength on arrival at the spot will still be about 66 millicuries. If this is applied to a patient for four days in succession he will receive a dose of about 32 m.c.d. which is often sufficient.

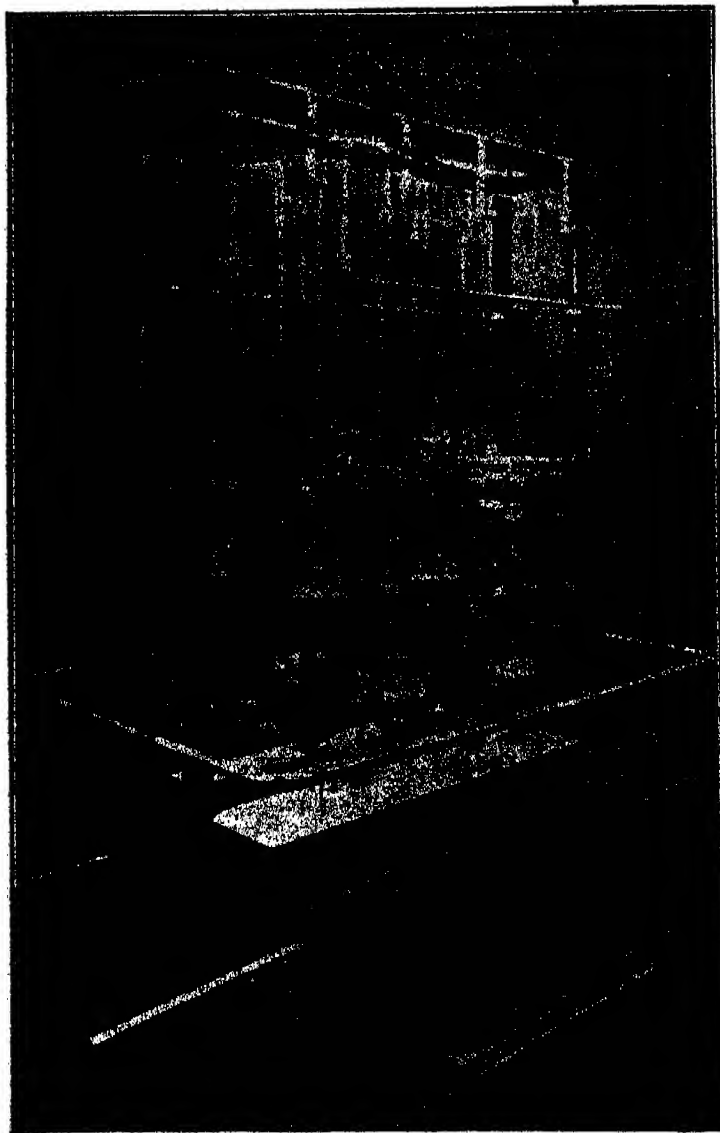


FIG. IV. Dr. Failla's Semi-automatic 'All Glass' Radon Apparatus.

The radium and X-ray treatment sections are under the charge of Dr K. M. Rai, F.R.C.S.E., D.M.R. who is assisted by two physicists, Mr V. A. Ponnaiya, M.Sc., and Mr V. Krishnamurti, M.Sc.,

Mr Ponnaiya may be given the honour of having installed the first radon extraction plant in this country.

Working at the radon plant is a risky job on account of the harmful effect of the powerful γ -rays from radium on the normal tissues and cells of human body. The two physicists work on alternate weeks at the radon extraction plant, so that none of them is exposed to an excessive dose of the radiation. They must also undergo frequent blood tests and compulsory one month's leave as required by the International Radium Protection Committee.

The description of the Barnard Institute of Radiology will be incomplete without mentioning its physiotherapy departments. There are about 20 Multostats giving Galvanic, Sinusoidal and Faradic currents for various baths, massages and ionisation, infra-red lamps, four spark gap diathermy, two German ultra shortwave units, hydrotherapy rooms and whirl-pool baths.

The hospital charges in all departments are according to the income of the patient. For persons with income less than rupees fifty per month and for the Imperial and Madras Government Officials the treatment is free. For people with income above Rs. 50/- there is a sliding scale of charges.

In such an Institute the protection against the powerful X-rays is an important item. The old practice of lining the walls of the departments with lead sheets would have costed about Rs. 80,000/-. A new method has been used in this Institute which has made a total saving of Rs. 60,000 possible. Ordinary clay bricks impregnated with barium has been used with a special mortar containing barium sulphate, cement and sand in the proportion of 3 : 1 : 1. About 170 tons of barium sulphate have been consumed by the whole Institute for this purpose. The doors of the X-ray rooms and radium rooms have been fitted with lead sheets so that the X-ray and radium departments have throughout a protection of about 8 mm. of lead which has been confirmed by tests in N.P.L.

Calcutta is the home of more than two million people compared to less than a million in Madras. In Calcutta, we have 250 mgms. of radium element in the Medical College, 175 mgms. in the Carmichael College and about 110 mgms. in the Chittaranjan Seva Sadan. Including the small amounts of radium kept at one or two private clinics and at the Bose Institute we have not even a gramme of

that precious element. Suggestions for preparing radon seeds were put forward in this journal* in 1935, but nothing could be done for lack of funds and initiative. The facilities for deep therapy are equally meagre in this big city. We have here several 200 kv. tubes but not a single 400 kv. unit while Madras can boast of two 400 kv. units, one at the Barnard Institute and another in the private clinic of Dr Rama Rao. This Institute also possesses one 200 kv. unit, Chaoul tube and Grez tubes for superficial therapy, Victor inducto-therms, h.f. units and about 100 mgms. of radium element.

In one respect Calcutta may well be proud. We will soon have here the first cyclotron unit to be built in India. This will be capable of delivering particles with 8 million volts energy, by means of which it will be possible to prepare artificial radio-active bodies.

Of the 92 stable elements, 87 have already been made radio-active by means of the cyclotron. These artificial radio-active bodies have half-lives very small compared to that of radium, but emit powerful β and γ radiations which may be used in the same way as radium. Some of these elements like Na, P, or C occur widely in the human body which is rather fortunate, since on account of their short lives they may be administered internally with no danger of cumulative effects like that of radium poisoning.

The cyclotron also delivers a powerful beam of neutrons. The density of ionisation along the track of neutrons is quite different from that along β and γ radiation. Thus at Calcutta will be available two entirely new methods of treatment of malignant growth inside the human body, viz., irradiation by fast neutron beam and administration of induced radioactive bodies.

Although it is too early to pronounce any definite opinion preliminary experiments have already shown that depth doses obtained with neutron beam are as good as with the most powerful X-rays. The radio-elements deposit selectively in certain cells, e.g., radio-phosphorus on bones, radio-iodine on thyroid glands. On account of this selective absorption most encouraging results have been obtained in the treatment of leucaemia by radio-phosphorus for which no other treatment was previously known. There is no doubt that these new methods will be most favourable additions in the science of radio-therapy.

* SCIENCE AND CULTURE, I, 138, 1935-36.

Use of the artificial radio-active bodies as tracers has opened up a vast field of research of fundamental importance. It is now possible to follow step by step the complex chemical and physiological changes occur-

found out. Thus radioactive S^{35} has been widely used as an index to protein metabolism, and for tracing the course of vitamin B, (thiamin) metabolism. It is gratifying to think that once the cyclotron is

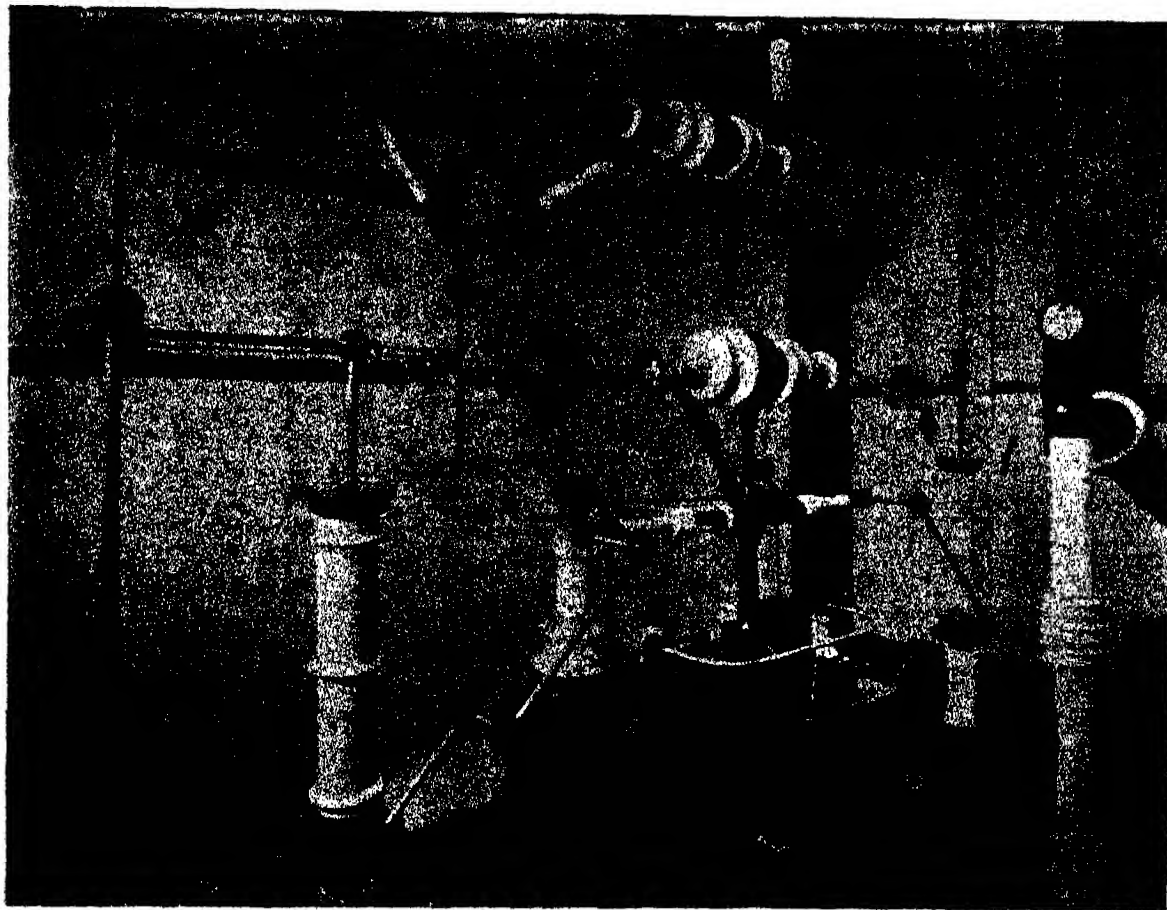


FIG. V. A portion of the High Tension Transformer Room.

ing in our bodies. Small amount of radio elements are mixed up with the normal ones and then with the help of Geiger-Müller Counter the radioactive finger print of the original mixture throughout the whole body is

in operation here these and many other fundamental problems in plant metabolism, *e.g.*, ion movement in living protoplasm, mineral nutrition (K, Rb, P, etc.) and movement in plants etc., may be taken up.

Sir Shah Mohammad Sulaiman

SIR Shah Mohammad Sulaiman was born in 1886 of a family of Muslem scholars and divines who had been settled at Jaunpur for over five hundred years. Amongst his most distinguished ancestors may be mentioned the author of Shams-i-Buzigha, Mollah Mahnuud, who wrote on the knowledge of sciences in the Islamic world, and was selected by the Emperor Shahjehan to undertake a journey to Samarkand for reporting on the famous astronomical observatory of Ulugh Begh, then the best in the world. His father Shaikh Muhammad Usman was a leading lawyer of the Jaunpur Bar. Even as a boy, Sulaiman had acquired a name for scholarship and his devotion to his studies while a student at the University



Sir Shah Mohammad Sulaiman.

Muslem Hostel at Allahabad was remembered long after he had left the place. He had a brilliant record in the University examinations and in the B. A. examination of 1906 he topped the list of successful candidates winning several medals. The late Prof. Ganesh Prasad was one of his teachers and from association with him, his natural taste for mathematical studies was further developed. On the result of the B.A. examination, he was awarded State

scholarship for study in England and proceeded to Cambridge. He passed his mathematics tripos examination in 1909 and the law tripos in 1910. Like all brilliant Indian students he tried for the Indian Civil Service in 1909 but was not amongst the selected candidates. He had naturally a second string to the bow, and qualified as a member of the Bar. In 1910 he was awarded the LL.D. degree of the University of Dublin. He returned to India in 1911 and first practised at Jaunpur as junior to his father for a year and then shifted to Allahabad in 1912. Within a short time he built up a very extensive practice and made his mark in a number of cases, as for example, the Rani of Sherkot's case, the Bamrauli case and the Dharampur case. He so much impressed two successive chief justices of the Allahabad High Court that he was offered a seat on the Bench at the early age of 34.

As judge of the Allahabad High Court, his record was very brilliant and through his efforts was built up the pre-emption law in the United Provinces. At the early age of 46, he became the permanent chief justice of the Allahabad High Court. During his judgeship he was called upon to act as the senior member of the Peshawar Enquiry Committee appointed to investigate into the cause of the riots in Peshawar in 1930. He was a member of the Capital Rates Tribunal along with Lords Dunedin and Tomlin and on the recommendation of this tribunal the Government of England agreed to bear a portion of the military expenditure in India.

As chief justice, Sir Shah Sulaiman's work was exceptionally brilliant. His quickness of mind and intelligent grasp of affairs enabled him to see through complicated cases in a far shorter time than other judges. His judgment on the Meerut Conspiracy Case stands as a landmark to his ability. This case had taken two years in the lower court and four in the sessions court and naturally it was thought that the appeal would last at least for months, if not years. But to the surprise of the public, the whole affair was finished in 8 days. Complimenting on this judgment in the Federal Court Case No. 1 of 1938 Mr. J. H. Morgan, K.C., the well-known English constitutional lawyer made the following remarks while delivering the Tagore Law Lectures at the Calcutta University:

"Now I have just been reading the judgments of the Federal Court at Delhi in that important case. One of

these judgments stands out conspicuous and pre-eminent and may well prove to be *locus classicus* of the law on the subject. It is a judgment worthy of the highest traditions of the House of Lords as an Appellate Tribunal and of the Privy Council itself. I refer to the brilliant judgment of Mr Justice Sulaiman. In depth of thought, in breadth of view, in its powers alike of analysis and of synthesis, in grace of style and felicity of expression it is one of the most masterly judgments that I have ever had the good fortune to read. Everyone in India interested in future development of the Constitution should study it."

The chief justice of a High Court has to do a lot of administrative work but Dr Sulaiman aided by his mathematical training reduced them to a routine and therefore unlike other judges could find time for other activities. He fought successfully for the rights of the High Court to remain aloof from local politics.

His connections with the educational institutions are too numerous to mention. He was one of the founders of the Muslem High School at Allahabad, president of Madrasa-i-Subhaniah, Warden of the University Muslem Hostel, member of the Executive Council of the University of Allahabad for over nine years. As president of educational conferences, muslem as well as non-muslem, he delivered addresses marked by loftiness of views and freedom from bombastic expressions or the usual platitudes. He consistently held the view that technical efficiency was one of the fundamental needs of the country, and insisted on this point in several convocation addresses at Dacca, Aligarh, Hyderabad and Agra.

WORK AT THE MUSLEM UNIVERSITY, ALIGARH

He was for two terms called upon to discharge the duties of the vice-chancellor of the Muslem University, Aligarh, once after 1928 when the University was in the midst of some internal commotions which lead to the appointment of the Rahmat Ullah Enquiry Committee by the Government of India. The members of the committee recommended far-reaching changes and the Government could find nobody better able to carry out these changes than Sir Shah Sulaiman. Though vice-chancellor only for a short time, he could give effect to the rules and regulations which had become obsolete, and was instrumental in obtaining a lump sum grant of 15 lakhs from the Government of India. Under his vigilant supervision definite terms of contract were laid down for employment of the members of the teaching staff, Urdu was made an independent subject of teaching in the B. A. examination, degree classes and teachers' training colleges were thrown open to women students and the finances of the

University were placed on a sound basis. So great was the respect felt for him by the Muslim community that during his second term of vice-chancellorship, the University had invested him with almost dictatorial powers. It is universally admitted that he established the Muslim University on a solid and sound foundation both educationally and financially. The standards of teaching were improved, higher scientific, historical and literary researches were given a fresh impetus. Like most energetic and intelligent men he sometimes failed to realise other people's limitations and expected everybody to work like himself. This sometimes caused a certain amount of criticism, but which usually subsided as soon as the critics found themselves in presence of his genial personality. After his transfer to Delhi as judge of the Federal Court, he found more time to take active interest in other educational institutions like the Anglo-Arabic College, and others less well-known.

AS A SCIENTIST

Sulaiman's interest in science dated from his student days, but like the late Sir Asutosh Mookerjee with whom he had much in common as regards temperament and tastes, he thought the educational line, as it existed in India in his student days, offered no field to an ambitious man who wanted to achieve distinction. But after he had reached the top of the ladder in his own profession, he made a determined effort to return to his first love. But like a sensible man that he was, he felt that he was long out of touch with the active streams of scientific life and approached the present writer to recommend to him such young scholars in physics who could carry on intelligent discussions with him on scientific topics. The writer recommended to him Dr D. S. Kothari, and when the latter left for Delhi, Mr Ramnivas Rai, both junior lecturers in the department of physics of Allahabad University. He was fond of the company of scholars and for every physicist and mathematician at Allahabad his doors were always open. For Dr Kothari he developed a genuine respect and affection and was instrumental in securing for him the readership in physics in Delhi University.

I cannot resist the temptation of adding a few lines by way of personal reminiscences. I have hardly come across five persons in this country who do not implicitly or explicitly believe in astrology or palmistry. Sulaiman was one amongst these very few, and he had an uncanny way of disconcerting these pretenders. Let me give one or two instances heard from his own lips: Some years ago one palmist appeared at Allahabad (I believe he was a

graduate and a practising lawyer somewhere in the mofussil), began collecting palm impressions of the most eminent citizens of Allahabad, and from these impressions, foretold their past, present, and future, their character, fate and so forth. He impressed the people tremendously and was able to obtain an introduction to Sulaiman. The latter readily agreed to give his palm impression, but requested the palmist to study the palm impressions of some of his acquaintances as well. To this the palmist readily agreed; and in time came forward with his story of the study of all the impressions. He naturally thought that the impressions must have belonged to members of the family or some intimate friends of Sir Shah Sulaiman, and adjusted the story of his study of the impressions accordingly. One can fancy the expression on his face when Dr Sulaiman revealed that the impressions were those of his butler, two domestic servants, and a sweeper, and proved this by calling these persons, and taking their palm impressions on the spot.

On another occasion, an astrologer was going strong, predicting the fortunes of well-known citizens of Allahabad. He somehow got an introduction to Sir Shah Sulaiman who told him in plain language that he had no faith in predictions supposed to be made on astrological grounds, but was of opinion that whatever successes the astrologers claimed were based on intelligent guess-work, and the law of chance. To prove this, he challenged the astrologer to enter into a competition with him in predicting the names of the prospective-knights on the coming New Year's day. The astrologer had no other alternative than to accept the challenge, and both his and Sulaiman's predictions were put in sealed envelopes and deposited with a common friend. After the New Year's honours were declared, the envelopes were opened, and it was found that the number of correct predictions were two more in Sulaiman's list than in the astrologer's. Dr Sulaiman had known that one of his colleagues on the Allahabad High Court was under orders of transfer to Lahore as chief justice and had guessed that he would be knighted on the New Year's day. The other success he scored over the astrologer was due to purely shrewd guessing; for the other names, only the law of chance was responsible. He thus demonstrated clearly the hollowness of the pretensions of astrologers.

SCIENTIFIC WORK

Sir Sulaiman tackled no ordinary problem in science but one of the most abstruse and fundamental

problems of the present times, namely, the Theory of Relativity. His work has aroused widespread comment, sometimes not very friendly, and therefore an impassionate view can be undertaken only after lapse of years.

Newton's law of gravitation which in conjunction with the Galileo-Newtonian dynamics had achieved signal success in explaining the motion of the earth, of the moon and the planets, and had helped in the discovery of new planets, was found to fail only in one case; it could not account for the motion of the perihelion of the orbit of Mercury amounting to 43" per century. For a long time this phenomenon remained an unexplained puzzle and therefore when Einstein published in 1925 his generalised theory of Space, Time and Gravitation, and offered an explanation of this phenomenon, it aroused widespread interest. At the time of the publication of the theory, only the perihelion anomaly could be explained, but Einstein made two other predictions *viz.*, that the light when passing near the disc of the sun would be deflected by 1'74" and secondly, light emitted on the surface of the sun would be shifted towards the red by an amount corresponding to a certain velocity of recession. These predictions were verified in the total solar eclipse expedition of 1919; and the theory of Generalised Relativity received official recognition from the scientific world.

The Generalised Theory of Relativity was the logical continuation of a series of work started by Einstein in 1905. The earlier thoughts are known technically as the Special Theory of Relativity. This dealt with electromagnetic phenomena, and were based upon two hypothesis:

- (1) Principle of constancy of the velocity of light measured in a moving and stationary medium.
- (2) Principle of invariance of physical laws.

These two principles necessitated a far-reaching revolution in our concept of the three fundamental physical quantities of space, time, and mass. The old idea of "absolutism" had to be given up, and the quantities were found to vary with the state of motion or rest of the observer. Since the Galileo-Newtonian dynamics is based upon the conception of absolutism of these three fundamental physical quantities, this had also to be given up and a new dynamics had to be constructed.

Amongst the deduction of this new dynamics was the equivalence of mass and energy, and the variation of mass with velocity. These deductions have received experimental confirmation, and in fact form

the cornerstone of the modern physics of the atom and the nucleus.

The generalized theory was a continuation of these thoughts, applied to the phenomenon of gravitation. The premises of this theory were based upon the experimental work of the Hungarian physicist, Baron von Eötvös, on the equivalence of inertial and gravitational mass. The mathematical symbolism required for expressing these thoughts was found in the very difficult Riemann-Christoffel theory of four dimensional geometry. It is doubtful whether, in spite of more than a quarter of a century which has passed since the first publication of the generalized theory, physicists and mathematicians have been able fully to comprehend the theory or grasp all its consequences, though the results of the special theory are universally accepted.

Sulaiman was one of the doubting 'Thomases' and it is well-known that 'intelligent doubt' of accepted notions lead very often to more far-reaching results than easy and unintelligent compliance with authority and tradition. He never believed, as has been implied by some critics, in the Platonic ideal that truth can be arrived at by mere discussion, but held like all modern scientists that the ultimate test of 'Truth' must be found in the comparison of the deductions of a theory with the actual facts of observation. It is true that he did not fully realise the importance of the manifold services rendered by 'Relativity' to modern physics, but he was sensible of his imperfections in this line, and was trying to make up his deficiency by hard study and constant discussion with his younger friends.

Sulaiman thought that Newtonian mechanics had not been correctly applied in the interpretation of astronomical phenomena for the assumption has all along been made that gravitation is propagated with infinite velocity, while it is quite possible that it is propagated with a finite velocity, which he later identified with the velocity of light. The idea is not new, but nobody appears to have worked it out.

He pointed out that if the velocity was finite, this force between two bodies would be different according as the bodies were at rest or in relative motion. Drawing an analogy from the aberration of light he showed that Newton's equations would require a slight correction when the source is in motion. By the application of the principle of retarded potential to Newton's law he deduced an equation which is identical with Einstein's, as far as the planets of the solar system are concerned, provided the velocity of propagation of gravitation

was assumed to be identical with the velocity of light. Accordingly, he had obtained the same value for the motion of the perihelion of Mercury as Einstein and could thus show that even Newtonian mechanics was capable of accounting for this phenomenon. He further showed that this theory accounts for the changes in the eccentricity and increase of semi-major axes of the orbits of Venus, Mars, and the Earth, and for a decrease in the case of Mercury, which is in accordance with Newcomb's observation as admitted by D. R. Hamilton. Further he offered an explanation of the observation that the eccentricities of relative orbits of double star components about their primaries tend to increase with increasing periods of revolution. For this none of the existing theories offered any explanation.

He also tackled the problem of the deviation of light coming from distant stars which happen to be just beyond the edge of the sun at the time of a total solar eclipse. If we ascribe to light corpuscular nature and a mass which is equal to the energy/ c^2 , then the deflection can be calculated on the supposition that the quantum of light is attracted according to the law of inverse squares. The deflection for a light ray which is grazing the disc is '87 seconds by the Newtonian method, but Einstein's value is just double, and this was apparently verified in the eclipse expedition of 1919. But observations by a German expedition in the eclipse of 1929 at Takengaon, Sumatra, showed that the coincidence was not so good. In fact Freundlich deduced from these observations that the ratio was more nearly 2.5 than 2. Sulaiman got a value which, according to different assumptions might vary between $7/3$ and $8/3$ and is therefore more in agreement with Freundlich's observations. The result of the observations made by Prof. Michailov of Russia at the time of the 1936 eclipse has not been announced but Sulaiman received a private letter in which it was stated that his value was more nearly correct than Einstein's. A full account of the present position was given by Sulaiman himself in "SCIENCE AND CULTURE".* Sulaiman was greatly interested in this observation, had Freundlich's paper translated at his own expense to realise fully all its implications, and was even thinking of organising a similar expedition of his own on the occasion of a future total solar eclipse.

It is also found that lines in a spectrum of light coming from the sun are shifted slightly towards the

* For details of Sulaiman's criticism of the Theory of Relativity and of exposition of his own theory, see SCIENCE AND CULTURE, I, 444, 1935-36; 2, 344, 1936-37; 3, 155, 1937-38 and 5, 366, 601, 1939-40.

red side of the spectrum, when compared with the spectral lines of similar atoms observed in a laboratory. Newton's theory is wholly unable to explain any such shift. By means of its postulates Einstein's theory accounts for such shifting. But according to Relativity the spectral shift should be the same for light coming from all parts of the solar disc, whether from centre, circumference or any intermediate point. For some time past it has been observed that there is an excess of the shift for light coming from the edge of the sun; but as this was unaccountable in Relativity it was ascribed to some unknown mysterious cause. Sir Shah's theory predicted that the shift for the light from the edge should really be about double of Einstein's value, and he published his prediction before the eclipse of 1936. At the time when he gave this result he was unaware that the result had been *empirically* deduced by the famous astrophysicist Dr Evershed who was at Kodaikanal in India. In fact, on the receipt of Sulaiman's result Evershed himself drew his attention to his work. The Government of India financed an expedition, led by Dr T. Royds, of Kodaikanal, to Japan to observe the total solar eclipse of that year. Dr Royds' observations were announced in July, 1937. It was a remarkable confirmation of Sir Shah's prediction that the extent of the spectral shift of light from the edge of the sun was actually found to be just double of Einstein's value and for any point of the surface is given by the formula $\Delta\lambda = \Delta\lambda_0 (1 + \sin^2\alpha)$, α being the angular distance of the point on the sun's disc from the centre.

Besides these results which are based on hypotheses to which no sensible objection can be taken, and were obtained by rigorous mathematical methods, Dr Sulaiman has written about gravitons, radions, nature of light, and of red shift of extra-galactic Nebular lines. There is, I must admit a slight touch of Aristotelianism in all these works, in as much as assumption have been made of particles and laws which have yet to respond to the physicists' identification parade. But this seems to be a feature of the times. The experimentalist and the observing astronomers have gone far ahead of the theoretical man with their explorations, and have discovered new facts and phenomena which do not fit in with the established order. Such are the cosmic rays, the red shift of Nebular lines, the nuclear reactions etc. The theoretical physicist unable to keep pace, falls back on speculations. Eddington counts the number of particles in the Universe; Dirac predicts anti-

particles; Milne gets all the equations of relativity dynamics, and quantum physics out of his cosmological principles, which in his hand act like a magicians' hat. Dr Sulaiman has also invented radions, gravitons, and light particles executing screw-motion. What are the values of these speculations? The answer is "Wait and See." In spite of spectacular advances in science and technology, those who are in the know of such attempts all feel that we are after all no better than Plato's chained men in a cave, unable to form any picture of the universe except from the shadows passing before us. If a keener mind sees in these shadows more than the ordinary mind, we can admire the ingenuity of such attempts, but surely cannot accept them until the predictions come within the range of reality. But at the same time, we cannot dismiss them as being merely speculative, for what intellectual progress has been possible without speculation?

The above brief sketch probably shows that the intellectual venture undertaken by Sulaiman was of no mean order. His earlier papers were as some critics had observed no doubt somewhat "impetuous" in tone, and "amateurish" in nature. But with growing acquaintance of other people's works, and opinions, the "scientist" in him was asserting more and more over the "lawyer".

It is indeed a great calamity for the country that a man like Sir Shah Sulaiman, who shed his lustre in more than one sphere, would be snatched away all of a sudden by the cruel hand of death. The loss is felt all the more by scholars all over India because Sulaiman unlike other men in high position eagerly sought their association and endeared himself to all who came in contact with him. His high office and reputation as a judge did not clothe him with ostentatious bearings. His genial personality coupled with his thirst for knowledge was a source of encouragement for many of our younger scientific workers. In Sir Shah Sulaiman, India has lost a brilliant and versatile mind and a person who as a jurist, scholar and educationist touched no branch of knowledge or of service which he did not adorn. He was one of the earliest subscribers to *SCIENCE AND CULTURE* wrote several articles for our columns, and was an eager reader. As a fellow and later president of the National Academy of Sciences of India for four years, he took more than usual interest in its proceedings, and very frequently helped the Academy liberally by monetary contributions from his own pocket.

M. N. S.

Notes and News

New World Populations

PROF. Raymond Pearl has made a comparative study of the statistics of the populations of the Western Hemisphere in relation to corresponding figures for the Old World and taking certain bases of comparison, such as density of population, percentage rate of growth, age composition and the like. The populations of the New World, have in a biological sense the characteristics of a young and vigorous organism, as contrasted with those of the Old. The density of aggregation in Central America is 37 persons per sq. mile, in North America, 17 per sq. mile and in South America 12.8 per sq. mile. In Europe it is 189.5 per sq. mile and in Asia 108.6 per square mile (U. S. S. R. being omitted). A relatively low density of population implies a comparative freedom of movement and expansion in settlement. The population of the New World is growing at a much faster rate than that of Europe, a higher birth rate affording freer play for the forces of natural selection and the production of a virile and healthy stock. The age composition of a population is of vital importance as reflecting the mass outlook on life. Taking the life cycle as falling into three divisions the figures for the Western Hemisphere are: pre-reproductive 39.0 per cent; reproductive 50.6 per cent; post reproductive 10.4 per cent; for Europe 27.9 per cent, 52 per cent and 20.1 per cent respectively. The higher proportion of young people in the New World are apt to display progressive and hopeful attitude and to be aggressive in social and economic pioneering.

Fluorescent Paints for Interior Lighting and Decoration

New effects in interior decoration by using fluorescent paints and ultra-violet lamps have been obtained in a Hollywood theatre. The whole of the walls and ceiling have been covered with suitable fluorescent paint and when the cinema pictures are shown the ultra-violet lamps are switched on. The auditorium then seems to be bathed in shadowless moonlight and the walls appear to have receded. The

audience has the impression of sitting under a blue night sky. For interior decoration, recently a number of paints has been developed giving, completely the whole range of colours, and landscapes can be painted on walls with the help of these fluorescent materials which are obtainable either as solid paints or transparent varnishes. White fluorescence can be obtained by applying two complementary colours, such as red and green, and at a distance from the surface the light mixes well to give an effect of white light. The transparent varnishes are invisible in ordinary light and display their characteristic colours only in the presence of ultra-violet light. The new scheme of decoration has another advantage. As a result of the use of ultra-violet light, air sterilization is also combined with the decorative effects.

Nazi Air Raid Damage

THE terrible loss of life and property inflicted by the activities of the Nazi air arm during the last winter in Great Britain is an inevitable consequence of warfare from the air. But the large-scale destruction of museums, laboratories, hospitals, libraries and cathedral churches throughout Britain seems to be the result of a settled policy revealing the intention with which the Nazis have entered upon this war. Their aim is not to secure military or material advantage alone, but at the same time to strike a deliberate blow at vital sources of spiritual and intellectual inspiration. Descriptions of damages done to institutions for the advancement of education, science or research by the Nazi air arm provide painful reading. In London which has been the storm centre of Nazi air raid the University college buildings have been very seriously damaged and the library with about 100,000 books has been destroyed. The King's College was hit by a high explosive bomb and the Westfield College and the Birkbeck College have been seriously damaged by incendiary bombs. The new buildings of the School of Oriental Studies and the buildings of the Goldsmith's College were also damaged and partly wrecked. All the important medical schools in the metropolis, viz., St. Bartholomew's, St. Thomas's, Guy's and London School of

Medicine for women and the Royal College of Surgeons were severely damaged.

The Royal Observatory, Greenwich, has been damaged by high explosive and incendiary bombs. The revolving globe and observatory clock and parts of the telescope room were damaged but the objectives and mirrors of the principal telescopes and other valuable equipments were dismantled and sent away for safety in the early days of the war.

The library buildings, the new building housing the departments of botany and geology and the Bute Medical Buildings of the University of St. Andrews have been seriously damaged.

In Manchester the University and the College of Technology have suffered damages. The buildings of the University of Liverpool have been extensively damaged and some of the laboratories destroyed.

Lately the Nazis have made several attempts to destroy London by fire from the air. Though London has withstood its ordeal some irreparable damage has been done. Guildhall has been completely gutted; eight Wren Churches have been wrecked, the house in Fleet Street where Dr Johnson compiled his dictionary has been burnt down. The British Museum was hit by a number of high explosive as well as incendiary bombs and considerable damage was done to the botanical collections and in other parts of the museum. The work of salvage and reparation is in progress but time alone can show how far the damage sustained is irreparable.

Giant Cyclotron at Berkeley

THE erection of the new 184-inch cyclotron (4,900 tons) at Berkeley, California is nearing completion. The cost of this apparatus (Rs. 26,00,000 nearly) is being provided by the Rockefeller Foundation. The concrete bed for the steel magnet, containing 1,200 tons of concrete has been completed. The erection of the steel work containing 3700 tons of steel is going on and will be finished very soon. 300 tons of copper in the form of strips will be used for the windings. This cyclotron will yield one hundred million electron volt deuterons in a field of 10 kilogauss. The development of cyclotrons within the last ten years has been amazing and reflects great credit on its distinguished inventor Professor E. O. Lawrence. Shortly after his appointment as professor of physics in the University of California at the age of 29, he erected the first cyclotron, a 4-inch instrument, in 1930. Then followed the erection of the 37-inch (85-ton) and 60-inch (220-ton) cyclotrons at Berkeley and now a much larger one is nearing

completion there. It is well known how the cyclotron has been extremely useful to physicists in recent years in their atom-smashing business. In fact the rapid progress in our knowledge of the inner structure of atoms and nuclei during the last ten years, would have been hardly possible but for this wonderful invention of Prof. Lawrence.

Approach of Mars

IN 1939, the planet Mars made one of its closest approaches to the earth and this provided a favourable opportunity for close observation of the planet's disc from southern latitudes.

Dr E. C. Slipher of the Lowell Observatory during the summer of 1939, took nearly 8,000 photographs of the planet from South Africa. He has discussed the results of his observations in a recent issue of the *Telescope*. The plates obtained show fine details. Dr Slipher claims that his photographs record so many of the 'canals' and 'oases' in the positions and of the forms shown on Lowell's maps of the planet, that the reality of these markings must now be regarded as beyond doubt.

Dr Slipher also points out that in none of the photographs the surface brightness of areas on the two sides of the canals shows any visible difference. This discounts the suggestion that the canals may be really nothing but divisions between areas of unequal shading. The observations of Dr Slipher seem to set at rest the long-drawn controversy regarding the reality of the Martian canals. The colour-filter photographs obtained by Dr Slipher suggests that the hazy north polar hood, which showed very rapid day-to-day variations of form is atmospheric in origin; it precedes and accompanies the deposition of the more brilliant white polar cap, and may consist of fine ice spicules.

Multiplying Books through Photography

IN the Library of Congress, Washington, there are more than 6,000,000 books, pamphlets, some 1,500,000 maps and charts, 1,400,000 volumes and pieces of music, over 500,000 etchings, engravings, woodcuts, and other prints, to say nothing of a vast stock of manuscripts—making it by far the largest collection in the world. The photographic duplication laboratory set up in 1938 with Rockefeller Foundation funds has made its resources available to writers, scholars and research workers in various fields throughout the world. In January, 1938, an appropriation of \$35,000 was voted and with these resources has been installed the new laboratory

containing a remarkable array of equipment, cameras of various sizes for photographing in microfilm, other cameras for photostatic reproduction, enlargers, processors, projectors—everything necessary for a complete duplication service. There is a photostat machine in which the sensitized paper is exposed, printed, developed, fixed, washed, and dried in an unbroken sequence of automatic operations. Another exceptional piece of equipment is a high speed microfilm camera with which bound books can be photographed page by page.

There is a great demand for photoduplications of those books, documents, prints, and other exceptional items which are rarely available outside. Thousands of requests are received for photostats of the Declaration of Independence, the Constitution, and the drafts of Lincoln's Gettysburg address. Once an item has been photographed, the film is added to the stock and future orders are supplied from it. Requests come from all parts of the United States, and from many foreign lands. The following figures will serve as an index to the growth of the service; microfilm exposures during the year ending June, 1937, were 13,643; during the year ending June 1940, they were 243,109. Similar efforts for furtherance of Indic studies in the United States were described in the article entitled 'America and Indic Studies' on page 126 of the last September 1940 issue of this journal.

The Library of Congress has received another Foundation grant for photoduplication, through the American Council of Learned Societies. Within recent months this Council completed a survey of the needs of American scholarship that can be met through microfilm copies of books and documents, and its first choice fell on the indexes of the Public Record Office in London. These provide the key to eight hundred years of British history. They give the dates, proper names and places, references to original documents bearing upon practically all the great personalities of government, trade, industry, science, literature, art, and other pursuits. A Chaucer scholar will find here, for example, references to all the official documents touching on the life of his hero—and so with researchers seeking data about Roger Bacon, Cromwell, Milton, Pitt, Isaac Newton, and thousands of others. In order that microfilming of these irreplaceable indexes may be begun at once, the Foundation appropriated \$30,000 to the Council in January. Plans are being made to have the microfilms brought to the United States as rapidly as they are completed, to be deposited in the Library of Congress. Here they will not only serve the convenience of scholars in America, but will constitute a valuable insurance in case one of the

original files in London is destroyed through bombing.

Sir Sarvapalli Radhakrishnan

SIR Sarvapalli Radhakrishnan has resigned his professorship of the University of Calcutta to join his new post of Sir Sayaji Rao Professor of Indian Culture and Civilisation at Benares Hindu University and also to render whole-time service to Benares Hindu University as its vice-chancellor. In addition to making scholarly contributions which have made him famous throughout the world as an exponent of Indian philosophy, Sir Sarvapalli has served Calcutta University in various capacities, as member of the syndicate, president of the post-graduate council of arts and as member of many important committees and delegations. In recognition of his scholarship and past services the syndicate of the Calcutta University has decided to appoint him emeritus professor of the University.

Sir Sarvapalli joined Calcutta University in 1921 as a successor to the late Sir Brajendra Nath Seal. During all these years he has made his mark not only as a great philosopher and scholar but has also served as an ambassador of Indian culture in foreign countries.

Annual Meeting of the Botanical Society of Bengal

THE fifth annual general meeting of the Botanical Society of Bengal was held on the 22nd February, 1941 at the Calcutta University Botanical Laboratory. The annual report, showed all round progress of the Society. The present number of members of the Society is 114.

The following were elected office-bearers and members of the Council for the year 1941-42.

President—Prof. S. P. Agharkar; *Vice-President*—Prof. S. C. Mahalanobis, Dr G. P. Majumdar, Mr S. N. Bal, Dr K. P. Biswas; *Hony. Treasurer*—Mr I. Banerji; *Members*—Dr S. R. Bose, Dr J. C. Sen Gupta, Mr J. C. Pal, Mr M. B. Dutta, Mr M. I. Chakravarty, Dr N. K. Chatterjee, Mr E. A. R. Banerji, Mr R. M. Dutta, Dr J. Chaudhuri; *Hony. Secretaries*—Dr S. M. Sircar and Dr B. C. Kundu; *Hony. Auditors*—Mr J. C. Banerji and J. B. Mukherji.

An exhibition and a conversazione were organised on the occasion, which showed a variety of interesting specimens. The list of exhibits included fossil plants, economic and horticultural plants, different strains of rice and sorghum and their hybrids,

mulberry with reference to silk-worm rearing, marine algae, mycology and plant pathology, pteridophytes, gymnosperms, cytology, different kind of vegetable fibres, medicinal plants and drugs, Himalayan plants, gymnosperms, cytology, different kinds of vegetable parasitic seed plants, insectivorous plants and Bengal timbers and there were several experiments showing life processes in plants.

Announcements

SIR Ziauddin Ahmed has been elected vice-chancellor of Aligarh Muslim University.

SIR KUNWAR Maharaj Singh has been elected vice-chancellor of Lucknow University.

Acknowledgment

We acknowledge with thanks the receipt of the following :

Journal of the Indian Institute of Science, Vol. 23A, Parts II—VII and Vol. 23C, Part I.

Reprints from the Journal of Osmania University, Vol. VII, 1939 and Vol. VIII, 1940.

NYLON IN A PROTEIN

Despite bombs and vast destruction in London, the editors of magazines published in that city still seem to have time to do a bit of original—humorous— thinking along scientific lines. So far as we know, no one in this country has pointed out the fact that nylon is a synthetic protein and that it, therefore, approaches closely to a food made of coal, air, and water. The editors of *Plastics* (London) after discussing the economics of the newer factory made fibres, have this to say about nylon :

"Carothers and his remarkable team of co-workers in Du Pont's have produced the first synthetic protein. True, it is not in texture very much like the proteins we encounter in life, except the skins and hornlike proteins, although it does resemble them all chemically. How much more would we thank Dr Carothers if he had devoted these years to producing a protein that would be more digestible than his nylon, which is so tough and not readily attacked by the gastric juices. Think of having a dozen chemical factories here turning out tens of thousands of tons of juicy nylon, already treated with dozens of vitamins and doses of the appropriate salts, extruded into just the right size for making sandwiches. And, of course, these factories would turn out not only beef flavour, but ham, lamb, and egg flavours, too! Think of the shipping we would save and how we could laugh at Hitler. This would be totalitarianism with a vengeance".

—*Scientific American*.

SCIENCE IN INDUSTRY

Indian Chemical Manufacturers' Association

THE Indian Chemical Manufacturers' Association came into being a couple of years ago. The latest report of the Committee for 1939-1940 shows that membership has increased and its representative character has been recognised by the Government of India. In view of the unsatisfactory position of the chemical industry in India which has been laid bare during the present war, the important role of such an association need not be dilated upon. The report *inter alia* presents a lot of information about the industry and reveals the difficulties facing the industry. The growth of chemical industry in this country has been unfortunately lopsided. Much spadework is yet to be done, particularly on key chemicals, and we are glad to note that besides the commercial aspects of the industry, *viz.*, freight, excise, protection and other government concessions, the Association are alive to other basic requirements on their own sides. They are apparently paying attention to exploring new lines of manufacture, and are also anxious to initiate and utilise researches bearing on their manufacturing problems. It is unfortunate that sufficient collaboration from the central and provincial governments did not come forth as was desired. Their indifference, as apparent in their replies to the various representations of the Association, is to be regretted. Let us hope that the solidarity of the Association will be strengthened and the increasing volume of public support will be instrumental in removing the handicaps which are retarding at the present time the development of the industry.

We have always stressed the imperative necessity of planning beforehand, whether for establishing new industries or for rehabilitating the existing ones. We hope that the members of the Association right from the primary stage will mould their policy as a whole and formulate co-ordinated plans, if necessary, by dividing work and sacrificing some of the monopoly interests of individual manufacturers, in order to ensure the general stability and smooth all-round development of the industry. It is encouraging to see that the Association appreciate the imperative necessity of collaborating with the universities

and other research institutions for work on specific problems. It is time that the Association created a body, say, a "Scientific Planning and Research Committee" representing the scientists of those institutions and themselves, who would survey the whole position of chemical industry in India and on the basis of this survey initiate and supervise research at the universities in a planned manner for the benefit of the industry. Much material regarding the country's needs and the present position of the industry has already been gathered by the Association and also by the chemicals subcommittee of the National Planning Committee, the Bengal Government Industrial Survey Committee and the Board of Scientific and Industrial Research. It should not take much time therefore to pool this information and to start work on research schemes. Already a few far-sighted and enterprising firms are financing researches at the universities and this initiative should be greatly encouraged. A more rapid advance would be made if the Association as a whole would adopt this plan through a permanent scientific planning and research committee.

More Substitutes for Foreign Drugs

MORE substitutes have been discovered for drugs formerly imported from England. One of these is nikethamide, which has now been synthesised by an Indian firm. Another chemical (sodium tauroglycocholate) used in bacteriological work has been manufactured by a Calcutta firm, and a sample approved by a Government bacteriological laboratory. Soap-nuts are being tried by manufacturing depots as a substitute for quilla cortex, an imported item used in the manufacture of liquor picis carbonas. Tolu, largely used in the manufacture of syrup tolu is now difficult to obtain and consequently experiments are being made to ascertain if tincture benzoin can replace tincture tolu, adding, if necessary, flavouring materials.

Since the stoppage of supplies enquiries have been directed into finding out substitutes of many imported drugs, and some have been already manufactured too by the indigenous firms. Brief notices of these appeared in the earlier issues of this journal.

Magnetic Chucks

WHEN thin piece of iron or steel has to be machined, the difficulty of holding the work comes out to be a serious problem. The jaws of a vice or of an ordinary lathe chuck fails to clamp it adequately. The difficulty has been solved by the use of a magnetic chuck which holds the work on its surface with sufficient strength so as to allow machining, scraping or grinding. The usual form of rectangular chuck for a machine bed consists of one or several electromagnets of the lifting type. When the current is switched on, the electromagnetic chuck holds the work to be machined, and as soon as the current is switched off the work is free.

But an electromagnetic chuck on a lathe presents difficulties. Here the chuck has to spin unlike those fixed on a milling or a shaping machine bed. Further, the ever widening use of A.C. electricity in machine shop and production plants is a bar against the use of an electromagnetic chuck. A special alloy steel has been made for making permanent magnets of extraordinary holding power, which will solve the problem of lathe chucks.

The special alloy steel contains aluminium, nickel, cobalt and iron and has been named 'Alnico' after the names of its alloying metals. A magnet of this alloy can lift a load of about 1,500 times its own weight.

The alloy was however originally intended to be a heat-resisting material, but its subsequent study of magnetic properties revealed its adaptability for making powerful permanent magnets. The magnetic properties of the alloy was first studied by Prof. T. Mishima of the Imperial University, Tokyo, and later the General Electric perfected the technique of heat treatment which improved the magnetic properties to a remarkable extent.

It may however appear that when such a strong permanent magnet is used as a holding chuck, it would be difficult to get the piece freed from its clutch. But its holding power can be switched 'on' or 'off' by the half-turn of a handle attached to it. This may be called the "flux-control". A set of such strong permanent magnets are arranged inside the outer casing, the top surface of which has several strips of high-permeable iron spaced regularly. When, again, the lever is turned to the "off" position, the set of magnets are brought just under the high permeable strips and the magnetic flux comes out copiously and holds the work placed on it. When, again, the lever is turned to the "off" position, the array of magnets shift away under the non-magnetic portions of the top plate, and the work-piece does not receive as much of the magnetic flux. The work is thus set loose.

Such non-electric magnetic chucks are available both in rectangular as well as circular forms, the latter for adapting on a lathe. All these chucks are perfectly sealed up so that the cooling fluid can be used safely over it.

K. R.

Paints from Indian Sources

ABOUT a dozen paint factories are operating with indigenous raw materials on modern lines in India today. These are producing dry colours, paste paints, mixed paints, enamels, varnishes, and oils. Paints required for war purposes including anti-venesicant, camouflage, and fire-retarding paints are also being manufactured now.

Research has been in progress to help Indian paint industry in many ways. In the laboratories of the Director of Scientific and Industrial Research has been developed a technique for manufacturing varnishes and paints from the Bhilawan nuts. The film is more flexible and resistant to shock than that given by any other product in the market. The Indian Institute of Science has completed research on the manufacture of pigmented lacquers in powder form and the Department of Director of Development, Cuttack, for lacquers on wood. Bleached lac, an important article in the plate varnish and nitro-cellulose lacquer industries, and hard lac resin for the varnish and electrical industries have been produced at the Indian Lac Research Institute. Processes of making varnishes from shellac and drying oils have also been discovered and short notices about these appeared in this journal. The College of Science in Nagpur, is making attempts to manufacture white lead paint, as well as metal and wood polishes.

At the Alipore Test House have been developed luminous paints from Indian ores and from calcium, strontium and barium sulphides at fairly cheap prices. These locally prepared luminous paints after being exposed for a few minutes to light begin to glow again and continue to glow for several hours. Luminous paints, may gradually replace neon signs used in advertising and in theatres.

India's Mineral Resources

IN an article contributed by Sir Lewis Leigh Fermor to the *Asiatic Review* (October, 1940) he has shown how India's mineral industries have expanded since the last war and reviewed the mineral ability of India which may be helpful in the present crisis. India's most important war minerals are coal,

manganese-ore, mica, iron-ore, copper-ore, chromite, and bauxite; and of all these, except copper-ore, India can make a substantial contribution to the common effort outside India. On the other hand, in respect of copper India is able to make a contribution by undertaking the smelting of imported blister copper. Apart from the manufacture of pig-iron and steel in the country, India could easily export large quantities of high-grade iron-ore should the need arise, whilst the exports of pig-iron to Britain could be enhanced. Sir Lewis observes that India's bauxite deposits are of considerable extent and high quality. If Germany could increase her output of aluminium from 18.9 thousand tons in 1935 to 165.6 thousand tons in 1938, it should be made possible for India to produce this essential metal and the cheap electric energy needed for it near the deposits in Bihar, Orissa, Central Provinces and Bombay should be made easily and early available.

The total average annual value of the war minerals has increased from £9,677,647 in 1914-1918 to £12,807,611 in 1934-38, whilst the total value of all minerals has increased from £9,860,185 to £13,609,844 in the same periods. Comparing the production of the two periods mineral by mineral, with the exception of gold, saltpetre, tungsten-ore and corundum, increases are shown by every mineral, often of very great extent. Specially noteworthy are the increases in the output of petroleum from an annual average of 7.3 million gallons to an average of 74 million gallons, due to the development of the Digboi field in Assam and to the success recently achieved in the Punjab; mica, from some 50,000 cwts. to some 177,000 cwts.; copper-ore from 8,000 to 339,000 tons due to the smelting by the Indian Copper Corporation in Singhbhum; the enormous increase in the output of iron-ore from some 400,000 to nearly 2½ million tons, mainly to meet the needs of the Tata Iron and Steel Company and the Indian Iron and Steel Company for the production of pig-iron and steel; the appearance of India as the world's largest producer of ilmenite*; and, finally, the substantial increases in the output of chromite, refractory materials, magnesite, and bauxite. The considerable increase in the production of coal from 18 to 24 million tons, though less than what had in some quarters been predicted, is yet substantial, and is part of a secular process due to expanding industry, the most important factor being the iron and steel industry, with its great consumption of coke manufactured from coal.

* It is derived from beach sands in Travancore and largely used in white paints. It is also useful for the manufacture of certain ferro-alloys and of titanium carbide, a superhard cutting agent.

Industrial Research at Bangalore

At the Indian Institute of Science, Bangalore, certain applied research schemes of direct value to industries have been taken up and it is understood that some particular war needs suggested by the Supply Department are being given special prominence. The following are the research schemes in progress:—

1. Investigations on phosphatic manures from the phosphatic nodules of Trichinopoly and from the bones in the Mysore State;
2. Use of gypsum for the manufacture of ammonium sulphate by reaction with ammonia and carbon dioxide;
3. Manufacture of urea and formaldehyde required for the preparation of synthetic plastic materials like bakelite and medical stores;
4. Manufacture of activated carbon for use in gas masks;
5. Manufacture of abrasives like carborundum and moulded graphite electrodes from carbon and purification of natural graphite;
6. Manufacture of condensers and resistances which can be used as components of radio sets;
7. Manufacture of drugs and allied substances and their pharmacological testing, needed for the army of India.

One of the lecturers of the Institute Dr K. R. Krishnaswami, is engaged in putting up a factory at Belagola for the Mysore Government which is expected to produce two tons of bichromate per day. The furnace for this manufacture was designed and the whole factory fabricated locally on the basis of investigations carried out in the Institute.

The question of supplying technical information to industrialists has been recognised by the joint-committee of the Court and the Council of the Institute to be of major importance. Through the efforts of the Council and the director, an increase of funds of the Institute from the current official year of about Rs. 40,000 has been secured. It is understood that an information bureau will be shortly started which will collect useful material for the industrialists.

Utilisation of Water Hyacinth In the Manufacture of Paper and Pressed Boards

M. A. AZAM

Industrial Research Laboratory,

Department of Industries, Bengal, Calcutta

WATER HYACINTH (*Eichhornia crassipes*) is a tropical polanderiaceous floating aquatic plant having spikes of large blue flowers and roundish leaves with inflated bladder like petioles.*

Prior to its invasion in Bengal, it existed in Brazil, United States of America, Bolivia, Siam, Cochin, China, Java and Burma. It became a serious pest in some of the rivers of Florida. It was in 1896 that the weed was first seen amongst the displays of the Royal Botanic Garden, Sibpur. The beautiful blossoms of the hyacinth attracted some men of aristocracy and aesthetic sense, who grudged not any exorbitant payment to own a few curious samples. By the end of 1905, the pernicious growth was no longer rare in the suburbs of Calcutta. In 1906, George Morgan, C.I.E., carried six plants from Calcutta to Narayanganj (Dacca). Some elites of Tippera and Mymensingh had in the same way courted this evil and by the end of the last Great War, the growth assumed quite an alarming magnitude. A special officer was, later on, appointed by the Government of Bengal, who in his report mentions of a serious infection of 4,269 sq. miles in 10 badly affected districts of the province. Agriculturists meanwhile had been faced with a menace in the terrible aggression of the plant, the manual clearing of which, to protect their cultivated plots of land, called for a growing burden of tedious labour. Gradually the task practically exceeded all bounds of feasibility. A chemical warfare against the plant was next tried with arsenic, sulphuric acid or other destructive chemicals but without any good result.

The first notable attempt to utilise the plant was made by the Department of Agriculture, Bengal, which established an experimental station during the last war period to extract potassium chloride from it.

*Webster—New International Dictionary. It is however curious to note that there is no mention of this weed in the Chamber's Dictionary, The New Oxford Dictionary, The Encyclopaedia Britannica, The Bengali Encyclopaedia (*Pistakoshha*) or Watt's Dictionary of Commercial Products of India.

Owing to a very bad interference of silicious and other earthy matters with ash the attempt did not prove fruitful from an economic point of view and the venture was therefore discontinued.

Subsequently, a wealth of information regarding the constitution of the plant was furnished and systematic work undertaken for exploiting this dreadful nuisance as a source of some commercial products.* The plant was investigated for the purpose of obtaining its KCl content (about 9 per cent on the dried plant) and to obtain information regarding its use as a source of fermentable sugars for power alcohol. Acetylation experiments yielded a triacetate crystallizable from chloroform. The air-dried fibre was treated at different temperatures with various concentrations of HCl and H₂SO₄ and the hydrolysis products were tested for reducing sugars. The best results were obtained by treatment of fibre with 4.5 per cent. H₂SO₄ to remove pentose and a second 2.25 per cent. acid hydrolysis gives a reducing sugar which is nearly all fermentable. Studies in bacterial fermentation of the plant show 33 per cent. cellulose decomposition (the percentage of total cellulose on the air-dried plant is 42.23).

The high percentage of KCl in the plant led one of the authors to formulate a scheme for manufacturing the chemical on a large scale but the idea was unfavourably criticised by the contemporary public and the press. The main point of objection was that the enterprise would rather be a venture for perpetuation of the weed than for its eradication which latter was really the country's immediate need. Moreover, the speculation was not based on very sound commercial considerations. At any rate, the investigations, in spite of their highly scientific and educative character could not make any substantial contribution to the problem of such utilisations of the

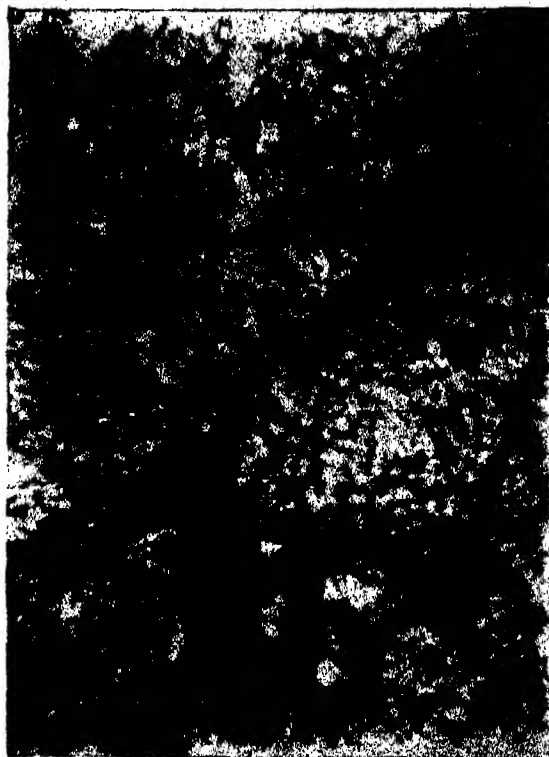
* Studies in the ligno-cellulose group—an investigation into the constituents of water hyacinth (*Eichhornia crassipes*) by Hemendra K. Sen, Patit P. Pal and Sindhu B. Ghosh. Jour. Ind. Chem. Soc., 6, 673-80, 1929.

MICRO-PHOTOGRAPH OF DIFFERENT FIBRES.

Magnification ... 70·5



Water hyacinth



Jute



Cotton



Straw

plant as might gradually and effectively lead to its eradication.

The growing anxiety of the Government then sought relief from the recommendation of a special committee with late Sir J. C. Bose as chairman. The findings of the committee regarding the most feasible means of fighting the scourge were as interesting as they were simple. We were told at last to root out the plant and throw them away by the hand.

In April 1939, a "water hyacinth week" was inaugurated by the Government of Bengal. Voluntary manual labour was invited to the cause of its eradication and a grant of Rs. 37,000/- was made by the Government for harnessing such labour from amongst those who are more or less directly affected by the scourge. It is estimated that, at present, this pest of the plant besides degrading the general sanitary atmosphere of the province is responsible for such a colossal wastage as 10 crores of rupees annually in output of crops.

Lately, the author of this communication has been doing some experiments to make a comparative study of various fibres as pulp for paper manufacture. Naturally attention was drawn to this much talked of weed. The work in this case was approached from the very start, with the share of the country's anxiety for an easy means of its eradication as well as the lingering optimism of the scientist for a simple mode of converting the aquatic growth into a commercial commodity. It is noteworthy, however, that previous workers have not recommended the use of hyacinth for paper making mainly on account of its poor yield of cellulose. But it has been confirmed by repeated experiments that the percentage of cellulose on the air-dried plant is 40—50 which is by no means small. Of course the percentage, if calculated on the green plant comes down much lower (2.15%) but that is, the author believes, no justification for discarding such a widely and abundantly distributed source of raw material. When any amount of it may be available free of cost almost everywhere in Bengal and the drying of the plant does not entail any appreciable cost of energy, the quantity of fibrous yield is certainly commensurate with a serious investigation into the feasibility of its commercial application in paper industry, particularly in the manufacture of hand-made paper which can be easily followed locally in the villages of Bengal. The idea is, primarily and fundamentally, to add some fascination and self-inducement to voluntary labour for eradicating the weed from one's neighbourhood.

The weights and linear dimensions of water hyacinth vary considerably in different samples.* We

have, however, found the following typical proportions of the different parts of the plant, green and dry.

TABLE I.

	Percentage of weight on the whole plant.		Percentage of length on the whole plant	
	Green.	Dry.	Green.	Dry.
Leaf	39.1	15.9	24.1	19.9
Stem	35.4	40.2	65.5	72.7
Root	25.5	43.9	10.4	7.4

Total weight of a large size green plant 455 gm. (1 lb. approx.).

Total length of a large size green plant 107 cm. (42" approx.).

Maximum girth of a large size green plant 2.6 cm. (1" approx.).

PREPARATION OF PULP

Water hyacinth is worked into pulp for paper-making very easily and practically without any cost of alkali or fuel. The alkali present in the ash† of the plant itself may be used in digesting liquor.

Even prolonged boiling with water alone followed by some mechanical trampling produces good pulp. In this respect it affords distinct advantages over bamboo, jute or sabai grass which require rather a drastic treatment, mechanical or chemical. Mechanically, the hyacinth works easier and quicker than paper cuttings, and chemically, than ordinary paddy straw. Again, as the long and healthy stems are better suited than the whole plant for the purpose of paper making, the thoroughly dried roots, leaves and a lot of the inferior grade of the plant may be used as fuel.* The whole ash being collected, washed thoroughly with water, the wash water may be utilised in the subsequent charge of boiling—thus completing a self-supporting cycle of manufacture which, we think, is of sufficient interest and of extraordinary simplicity to command a popular appeal.

10 gms. of air-dried stems of water hyacinth were cut into small pieces, washed clean and boiled in 500 c.c. of water in a conical flask fitted with an ordinary reflux condenser. Similar experiments were repeated with an emulsion of slaked lime or solutions of washing soda, caustic soda or the wash water from the hyacinth ash. On cooling, the supernatant liquid

† The percentage of alkali carbonate in hyacinth ash is known to vary from 1.5 to 8% and thus comparable in richness to some alkali sands in India and Burma.

* We had a good deal of trouble in getting a good fire from the inferior plants and rejects. The calorific value (7700 B. Th. U.—Determination of H. K. Sen and his collaborators—*Jour. Ind. Chem. Soc.*, 6, 673-90, 1929) was in our favour. But our attempts to harness the same were at first very badly answered by clouds of suffocating smoke. Gradually, by practice and manipulation, things came to order. A small proportion of cowdung cakes or wood fuel to supplement them greatly improved the quality of fire.

* Samples of water hyacinth used in these investigations were collected from the suburbs of Calcutta.

or the sediment of lime etc., was carefully removed and the material pasted in a mortar. The yield of paper producing pulp was calculated after washing and drying the fibres completely.

TABLE II.

Digesting medium.	Time of boiling.	Percentage† of paper making fibre on the weight of dry material used.
	**	
Water	5 hours.*	66.5
1% Emulsion of Ca(OH) ₂	2 "	65
1% solution of Na ₂ CO ₃	2 "	45
1% Emulsion of a mixture of Ca(OH) ₂ and Na ₂ CO ₃ in equimolecular proportions	2 "	43.5
0.5% NaOH	2 "	35
0.25% "	2 "	44
0.125% "	2 "	45
Wash water from hyacinth ash (3° Tw. at 66°F.)	3 "	43

Attempts were first made to use pulp from the whole plant for paper making, but this greatly degrades the quality of produce. The dried leaves being comparatively brittle, and the roots rather dark and stiff, the paper from such pulp becomes dirty, brittle and gritty owing to unequal tension of fibres and interference of silicious particles.

MAKING OF PAPER SHEETS

The pulp from the stems of the plant gives the most satisfactory results. The wonderful potency and luxuriance of the notorious growth was expected to leave some characteristics in the fibres and curiously enough they showed some distinct peculiarities. The fibres are very fine as their microphotographs in relation to those of jute, cotton and straw have clearly indicated. This accounts for a close cementation of the fibres in formation of paper sheets so that the pulp, without incorporation of any sizing material like rosin or alum produces a certain quality of paper which is quite strong and does not at all soak ink. The common sources of raw material for paper making cannot however, do without 'size' to ensure strength or resistance to water. The bleached pulp produces beautiful white translucent sheets up to a certain thinness which being exceeded brings in a brownish appearance. This paper has a high natural glaze and a remarkable power of water resistance. Although such sheets afford good writing surfaces and do not soak ink in the least, the translucent character does

not however recommend their classification with ordinary writing paper. To a great extent they resemble oil paper and might be used as wrapping or poster papers.

Attempts to reduce this drawback were next made by introducing a small percentage (8 to 10%) of jute or cotton fibres in admixture calculated on the weight of dry hyacinth used. This greatly improved the colour and opacity but made the paper non-resisting to water in proportion to such adulterations. This, however, is much minimised by making the adulterating pulp finer, so that the finally prepared mixture is of a homogenous consistency for all practical purposes. The proportion of size required is then considerably reduced. The finished paper shows good strength, appearance and smoothness and may be used for writing purposes.

Pulp (wet) from 2 lbs. of air-dried stems prepared by boiling them in an iron pan with waste water (3° Tw at room temp) of the hyacinth ash, was bleached with commercial bleaching powder (½ oz.), thoroughly washed and then mixed with jute pulp (from 2½ oz. dry jute). ¼ oz. rosin soap and an equivalent quantity of alum taken separately into clear solution with water were successively mixed with pulp. This was then put into a large quantity of water in a small galvanised iron tank, stirred with a stick so that a thin suspensoid was formed from which sheets of paper were lifted by means of a brass sieve and placed flat on table. Each sheet was covered with a piece of muslin of a slightly larger area and when the tank was practically exhausted of pulp the heap of paper was pressed under an ordinary flat screw press which squeezed out water and imparted better texture to the sheets by compression. They were then dried in the sun and lightly polished.

The weight of paper collected—13 oz. (approx.).

Number of paper (foolscap size)—37 sheets.*

Eighty lbs. (about a maund) of dry water hyacinth will give nearly 30 lbs. of stem which will require:—

8 oz. bleaching powder costing about Rs. 0-0-6	
36 oz. jute**	" " " 0-1-6
8 oz. rosin soap	" " " 0-1-0
4 oz. alum	" " " 0-1-0

Rs. 0-4-0

and produce one ream or 20 quires of foolscap size paper valued at Rs. 2-8-0 only. An average agricul-

* This does not represent the percentage of pure cellulose but only the quality of pulp available for paper making.

** Does then, this required a more vigorous grinding to give a comparable consistency.

* In actual practice, 148 sheets of quarter foolscap size were lifted.

** For this purpose waste jute easily available in the villages are best suited. We however put a nominal price against the item.

turist family consisting of 3 male members each working for half an hour daily can easily eradicate 15 maunds of the green weed. During the six dry months of the year it is possible to collect 140 maunds of the dried plants. If only one quarter of this quantity be converted into paper it will give a return of Rs. 80/- per annum, which amount will surely give some relief to the poor peasants. By selling the finished goods as envelopes and writing pads etc., the output value may almost be doubled. The equipment essential for producing such paper will hardly cost more than Rs. 25/- and the idle hours of the cultivator family will amply provide for the necessary labour.

PRESSED BOARDS AND TILES

The pulp from water hyacinth was next tried in the production of pressed boards with still better results, and, in fact, it is believed that this can be easily commercialised and even feed the machines thus providing the most effective eradication of this scourge. The author has used a pressure of 2 tons per sq. inch in a small hydraulic press. The unbleached pulp without admixture of any other filler or binding material such as china clay, gum, glue or starch make very tough boards which have been found to be far superior to ordinary straw boards in strength and resistance to water. In fact, purely hyacinth boards of thickness $\frac{1}{8}$ "— $\frac{1}{4}$ " resemble the modern 'masonite' articles which at the present day are widely used for indoor partitions etc., and hold a considerable market. The bleached pulp gives white samples of boards. In this case, a small percentage of finely ground jute stalk (10%) and a little proportion (4 to 6%) of waste paper pulp are admixed with it to obtain optimum results. Asbestos wool (5%) has also been tried as filler for better samples with satisfactory results.

Water hyacinth pulp has been successfully employed in *papier mache* for the production of artificial surfaces or simple mouldable sheets. The authors imitated twig surfaces in making fancy walking sticks by applying a coat of hyacinth pulp on a bamboo stick. The degree of adhesion was remarkably high as also the uniformity and flexible nature of the coating, which on keeping does not show any appreciable loosening or crack. A few lampshade designs worked out of hyacinth pulp was also interesting and attractive.

Last but not the least important is the utilization of hyacinth in making tiles. A quantity of pulp is first thoroughly kneaded with a proportion of cement and whiting and worked out in moulds as in the case of bricks. The tiles are baked in the sun. The com-

position may also be pigmented. The fibrous interference greatly enhances the tensile strength of the tile and reduces the weight of the product to a considerable extent. Although the author has not yet completed these experiments and cannot definitely specify any commercial use for the new tiles, they do undoubtedly hold out bright prospects of useful applications. Besides the above exploitation water hyacinth can be put to other uses.

DETERGENT PROPERTIES

On account of the high alkali content the ash from the hyacinth has been found to possess good detergent properties. Soils recommended by the American Society of Detergent Chemists were used in the experiments.* The villagers can thus save a considerable fraction of their expense for soda or soap by taking advantage of this simple, profitable and practical utilisation of this plant.

FODDER FOR CATTLE

The green plants are increasingly used by the 'goalas' and carters of Calcutta as fodder for cattle. It has been gathered from experienced 'goalas' that the fodder increases the percentage of cattle's milk by 30 to 40% but the quality gets impaired owing to an increase in the percentage of water in milk. The dried plant, on the other hand, does neither increase the quantity of milk, nor degrade its quality. The author has tested the latter as fodder with success. But it requires a bit of tutoring. When once habituated it becomes a favourite food with the cattle so much so that the author had to lose a good quantity of his collection of dried plants from the invasion of an accustomed buffalo.

A MANURING PLANT

The presence of insoluble calcium phosphate in the plant favours the speculation of utilizing it as manure. Attempts for rendering the quantity available for assimilation have not, so far, been seriously made, thus leaving out a task for our agricultural chemists.

CONCLUSION

Thus, the agriculturist who has a growing concern and dread for this pest may switch on a part of

* A standard soil is composed of 2 gms. lamp. black, 5 gms. lubricating oil, 3 gms. tallow, and 2 litre carbon tetrachloride.

his idle hours daily to its eradication with a view to utilising the plants in one way or the other. The more ambitious of his class may try to earn directly from this hated scourge by producing paper and pressed boards etc., while others may at least use it as a detergent, fodder or manure and thus make a little saving out of their normal expenditure, however meagre it may be.

The most important feature about such utilisations is that the practice of removing the plants for certain use will be continued with great zeal till the extinction of the species. A recovery of the tremendous wastage of 10 crores of rupees in annual output of crops will be no small acquisition to our poor province and the clearance of the waterways will certainly make a healthier Bengal. The people will be very little benefitted by one 'water hyacinth week' however successfully observed if the once cleared areas be not made immune from further infection by some simple and practical means such as have been shown in the foregoing pages.

SUMMARY

Water hyacinth is a serious menace to agriculture and has affected severely the health and sanitation of Bengal. It is responsible, according to recent estimates, for a substantial fall in agricultural revenue of the province and an alarmingly high mortality

from malaria and other epidemic maladies, particularly in rural Bengal.

This evil, apparently without any redeeming feature or helpful use, has been successfully utilised by the author as a raw material for manufacturing wrapping paper, writing paper, pressed boards and articles resembling the modern 'masonite' products, *papier mache* for producing artificial surfaces or simple mouldable sheets. A self-supporting process of preparing pulp from the hyacinth has been worked out and the process may be followed on a cottage scale in the villages of Bengal as it does not involve any considerable outlay of capital or elaborate establishment.

The dried plant has also been found to be useful as fodder for cattle and its ashes possess good detergent properties.

The object of the present investigation has been mainly to find out some practical methods of utilisation of the plant, which could at the same time provide an incentive to those who are directly affected by the scourge, for the eradication of the plant on a larger scale than is ordinarily attempted at.*

* In connection with this work the author is specially indebted to Mr S. C. Mitter, Director of Industries, Bengal, and Dr A. Karim, Deputy Director of Industries, Bengal, for their kind encouragement and valuable suggestions. But for their helpful guidance the work would not have been completed.

MEDICINE & PUBLIC HEALTH

Blood Transfusion

REFERRING to the article on Blood Transfusion in this section in the April, 1941 issue of this journal, Sir Upendranath Brahmachari has kindly drawn our attention to the fact that there is a properly organised blood transfusion service in Calcutta. This service is conducted under two heads, one under the imperial serologist, and the second under the style of the 'Blood Bank'. The 'Blood Bank' in Calcutta is run by the Bengal branch of Red Cross Society under the chairmanship of Sir Upendranath, and is the first of its kind in India. It stores blood after proper testing and classification into groups for immediate supply to those who may not get suitable donors in time of emergency. It also keeps a register of donors properly classified and acts as a liaison between the hospitals and the public, and the military, when requisitioned. A detailed account of this work was published in the past fifth volume of the journal on page 233. Similar service is reported from Bombay under the Bombay branch of Red Cross Society.

Vitamin A from Fish Liver Oils

THE first record of the high vitamin-A potency of some Indian fish liver oils was made by Guha and co-workers in 1933, who reported that some of these oils were many times more potent than cod liver oil and a few of them had almost half the activity of halibut liver oil, which is the richest liver oil so far known. Investigations which have since been carried out in various parts of India have confirmed these observations. Shark liver oil is now being commercially produced and sold by the Madras Government. Work on the vitamin A of fish liver oils is continuing at Calcutta University, Dacca University and All-India Institute of Hygiene and Public Health. It has been found that "Air" and "Boal" fish liver oil have a vitamin-A content nearly half of that in halibut liver oil, while that of certain samples of "Dhain" and "Shole" liver oils is nearly equal that of halibut oil. It is hoped that the commercial exploitation of the richer oils will shortly begin in this country.

School Health Work in the Punjab

School health work can play an important part in promoting welfare of the community by socialising the outlook of the children and by providing them with opportunities for active participation in health work. In this connection the lead given by the educational authorities in the Punjab may be quoted as an example deserving adoption in other parts of India. In 1925 and 1926 district community councils were established at the headquarters of each district in the province with the district inspector of schools, in the majority of cases, as the secretary. Another innovation was that community work was introduced as part of the course at the training schools for vernacular teachers. The village schoolmaster can play an important part in rural development. His intelligent co-operation is necessary not only for securing the goodwill and confidence of the people when new and unfamiliar ideas are presented to them, but also for instilling in the minds of the rising generation certain elementary principles regarding health, agriculture and co-operation which are all essential for developing community life on proper lines. The training course for pupil-teachers includes these subjects and special emphasis is laid on the practical application of the principles that are taught. They are taught to organise among themselves and manage on their own initiative supply societies, thrift societies and Red Cross societies. They are taught elementary hygienic principles and are required to carry out, with their own hands, such works as the cleansing of streets, removal of vegetation from choked drains and disposal of manure and street sweepings in pits. They are also taught simple facts relating to the control of infectious disease, improvement of housing conditions and methods of health education. In consequence of these changes in the curriculum in training schools for teachers, it is stated that the pupils of rural schools are taking an active part in health work and in other measures designed for the welfare of the people. During epidemics, they assist by active propaganda in the carrying out of preventive measures such as chlorination of wells, vaccination against small-pox and inoculation against other diseases. They also take part in the distribution of quinine during epidemics of

malaria and in intensive cleanliness campaigns in the villages situated close to their schools. Apart from the direct benefit that accrues to the community from these activities, the possibilities arising out of the training, that awakens in these children the desire to serve the community, cannot be over-emphasised.

Supplementary Milk Diet in School Children

The Chief Medical Officer of Delhi reports certain results with milk as a supplement to the diet of children. He concludes that the addition of one pound of whole milk to the diet of the child has a profound effect on his health and growth, that half a pound of whole milk, while not productive of striking results, produces appreciable benefit and can therefore be recommended for wide adoption and that a pound of skimmed milk appears to have approximately the same effect as half a pound of whole milk. The price of half a pound of pasteurised milk is only 9 pices, while a pound of skimmed milk similarly treated costs one anna, indicating therefore that whole milk should be preferred on economic grounds.

Protected Water-Supply in India

The Indian Public Health Commissioner's Report for the year 1938 is responsible for the statement that, in that year, the municipalities of British India spent 28.9 per cent. of their revenue on public health activities, of which 74.2 per cent. was spent on conservancy, water-supply and drainage, while the corresponding figures for the district boards (*i.e.*, rural areas) were 7.2 per cent. and 25.4 per cent. respectively.

The minimum requirements for sanitation in villages may be stated to be the provision of a safe water-supply adequately protected against contamination, drains to remove sullage from the inhabited area and a satisfactory system of night soil and refuse disposal. The provision of protected water-supply is a reasonable criterion by which the level of sanitary improvement attained by a community can be judged. In 1938, 19.6 per cent. of a total number of 1,229 towns of all sizes, possessed a protected water-supply, the proportion varying between 6 per cent. in U. P. to 83 per cent. in Delhi. In Bengal, only 2.5 million people out of 50 millions enjoyed the benefits of a protected water-supply. In rural areas the position is hopelessly inadequate. Compare this with England where 7/8ths of the rural population are provided with a piped water supply and with U. S. A. where most rural areas with a population of 1000 enjoy that amenity.

Vitamin C and Tuberculosis

SEVERAL observers have reported that patients suffering from tuberculosis are unsaturated with vitamin C. (Hasselbach, *Klin. Wchnschr.*, 16, 472, 1937; Heise *et al*, *Brit. J. Tuberc.*, 31, 23, 1937; Sebok *et al*, *Tuberculosis*, No. 12, 1937; Trautwein, *Beitz. z. Klin. d. Tuberk.*, 91, 411, 1938; Bauer *et al*, *Beitz. z. Klin. d. Tuberk.*, 91, 262, 1938; Martin *et al*, *Amer. Jour. Digest. Dis. & Nutrition*, 4, 368, 1937; Abbasy *et al*, *Lancet*, 2, 1413, 1936; Banerjee *et al*, *Nature*, 145, 706, 1940; Banerjee *et al*, *Ann. Bichem. Exptl. Med.*, 1, 27, 1940). The cause of unsaturation in tuberculosis may be due to the combined effects of the diminished intake of vitamin C with the food, increased destruction of the vitamin by the disease and elimination of the vitamin in the urine in a combined form. The role of vitamin C in tuberculosis has been studied by various workers. Petter (*Lancet*, 57, 22, 1937) and Sande (*Klin. Wchnschr.*, 17, 1745, 1938) are of opinion that vitamin C with gold therapy reduces the tendency to form haemorrhages. Trautwein (*loc. cit.*) treated tubercular patients with intravenous injections of vitamin C, 200 mg. a day, until the patients were saturated with vitamin C. He observed remarkable improvement in the condition of his patients as manifested by gain in weight, fall in temperature, decrease in red cell sedimentation rate and a favourable blood picture. Heise *et al* (*loc. cit.*), however, observed no clinical improvement after treatment with vitamin C in tubercular patients. Bauer *et al* (*loc. cit.*) are of opinion that the action of vitamin C in tuberculosis is not specific but it only improves the general condition. Sweany *et al* (*J. A. M. A.*, 116, 469, 1941) have studied extensively the role of vitamin C in tuberculosis. They have estimated the vitamin C content of the whole body in normal persons and in persons suffering from tuberculosis. Vitamin C content of the normal young adult human body varies from 3 to 6 g. In active tuberculosis the total quantity of vitamin C may be less than 300 mg. even on a fair vitamin C intake. In advanced disease, tissues like muscle, fat, bone and skin lose nearly all their reserve of vitamin C while the bulk is retained in the vital tissues like brain, liver, hypophysis, adrenals, gonads, pancreas and spleen. They have also studied the effect of administration of (1) an orange flavoured preparation containing synthetic vitamin C, (2) orange juice containing the equivalent amount of vitamin C and (3) a synthetic orange flavoured preparation without vitamin C, in three groups of patients. After six months they observed that of 31 patients in the vitamin group (No. 1) 23 remained alive. In the orange group 23 remained to the end out of a total of 33 patients, whereas, in the control group out of 34 patients 14 remained to

the end. This shows beneficial action of vitamin C in prolonging the life of the treated patients. The patients in the different groups who survived after six months, however, showed little change roentgenically between the composite figures of the different groups. The weight gain or loss in the different groups revealed a similarity of all three groups. A favourable haematinic effect in the treated patients were observed.

S. B.

Combined Artificial Fever Chemotherapy in Gonorrhoea

SEVERAL workers have observed the usefulness of artificial fever therapy in the treatment of gonorrhoea (Bierman *et al*, *Am. J. Med. Sci.*, 191, 55, 1936; Desiardins *et al*, *J. A. M. A.*, 106, 690, 1936; Owens, *J. A. M. A.*, 107, 1942, 1936; Humiston, *Am. J. Syph. Gonorr. & Ven. Dis.*, 21, 554, 1937; Warren *et al*, *J. A. M. A.*, 109, 1430, 1937; Parsons *et al*, *J. A. M. A.*, 109, 18, 1937; Schnabelet *et al*,

Am. J. Syph. Gonorr. & Ven. Dis., 22, 39, 1938; Kendell *et al*, *Am. J. Surg.*, 24, 428, 1935). Since the discovery of the sulphanilamide group of drugs which has revolutionised the treatment of gonococcal and other infections, the artificial fever therapy has hardly been in use nowadays. A few cases of chemotherapy-fast strains of the gonococcus have been reported (Westphal *et al*, *J. Bact.*, 39, 47, 1940; Herrold *et al*, *Am. J. Syph. Gonorr. & Ven. Dis.*, 22, 705, 1938). Kendell *et al* (*J. A. M. A.*, 116, 357, 1941) studied the effect of combined artificial fever chemotherapy in 83 patients suffering from gonococcal infections resistant to chemotherapy. Of the patients resistant or intolerant to chemotherapy receiving fever therapy alone, 62.5 per cent were cured following a single ten-hour treatment at 106°F. A single ten-hour artificial fever therapy, combined with the administration of adequate sulphanilamide for eighteen hours prior to the fever treatment, cured all the patients in a group of thirty one patients resistant to chemotherapy.

S. B.

Social Aspects of Malaria

G. COVELL

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MALARIA is so familiar a disease to most people who live in India that they regard it as one of the ordinary features of everyday life. It is seldom that the average individual realises what a profound influence this disease exercises as a dominant factor of human existence over a very large proportion of the world's surface. This is partly due to the absence of the dramatic element in the case of malaria and partly to its low case mortality, as compared, for instance, with that in cholera, small-pox or plague. Yet the total deaths from these three diseases combined represent only a fraction of the mortality caused by malaria in India every year.

Although the case mortality from malaria is probably less than one per cent., it has been estimated that in this country the disease is directly responsible for more than one million deaths per annum in a normal year, while in years when great regional epidemics occur, this figure may be greatly exceeded. In the great epidemic which swept over Northern

India in 1908, there were 250,000 deaths from malaria in the Punjab, and 10,000 in the city of Amritsar alone. Apart from the deaths directly attributable to malaria, the lowered resistance of the body resulting from repeated attacks renders the victims more vulnerable to infection by other diseases, such as tuberculosis or pneumonia, and it has been estimated that these indirect effect of malaria are responsible for a further one million deaths per annum. In certain instances, the ravages of malaria have been so overwhelming that whole tracts of fertile country have been abandoned or have remained undeveloped.

It has been said that malaria was an important contributory cause of the decay of certain ancient civilizations, including those of Greece and Rome, and this is probably true to some extent, although there are so many other factors to be considered that it is difficult to evaluate the extent to which the disease may have operated in these cases.

In the past, it has sometimes been asserted that malaria exerts an important influence on the birth-rate. A recent paper by Gill (1940) has, however, shown that, apart from a temporary decrease as the result of some reduction in the number of conceptions occurring at the height of an epidemic, there is no appreciable effect on the birth-rate as the result of malaria. Gill concludes that there is little fear that a reduction of malarial incidence as the result of control measures would aggravate the evils of over population.

Whatever may be said regarding the influence of malaria on the numbers of the population, however, there can be no doubt whatsoever regarding the baneful effects of the disease upon the general health and economic conditions of the community. This subject has been discussed in great detail in a remarkable series of articles by Sinton (1935-36). "Apart from its action upon the body, anyone who has suffered from malaria or who has observed closely cases of this disease cannot fail to have noticed its effects upon the mentality of the sufferer. Mental activity is dulled, irritability is the rule, initiative is lacking, decisions are put off or reached with difficulty, ambition is lost, and depression is a prominent symptom. While such mental states may only be of temporary duration in patients who are liable to obtain proper treatment, it is different among the large proportion of the population in malarious areas of India, where few persons ever get such adequate treatment. One has only to visit a highly malarious village to see these mental symptoms emphasized and multiplied manifold." Sinton goes on to point out that whilst such mental states in the adult may not be of very great importance as a factor in the causation of economic loss in the case of unskilled labour, it is otherwise with regard to skilled work, for not only is the quantity of such work diminished, but its quality also deteriorates. "Where large sums of money and great responsibility may depend upon the initiative, upon the formulation of a definite and considered policy and upon rapid and expert decision, the results of such an unbalanced mental state may be productive of serious consequences, financially and otherwise. It must also be remembered that, apart from the sickness of the worker himself, his state of mental anxiety may be determined by serious illness caused by malaria among the members of his family."

Observers in the U. S. A. and in South Africa have studied the effects of malaria upon the child population of those countries, and in both cases the disease has been shown to be responsible for the backward condition of the school children living in malarious localities. A child who has suffered from

a series of fever attacks in his early life, is not likely to obtain the benefit from the school curricula which is derived by his healthier class-mates. Apart from this, there is the interference with attendances at school owing to malaria attacks to be considered.

Jones (1909) has pointed out that mental lassitude brought about by the disease tends to become fixed in later life. "The dwellers in malarious regions, consciously or unconsciously recognising the peril, tend to avoid toil, either of mind or body, if it be so violent that an attack of fever may be expected to follow. In time the impulse becomes stereotyped as a habit, and so laziness and lack of enterprise are marked characteristics of these unfortunate people. Each generation, as it is born, is subjected, not only to the same physical surroundings as were its parents, but also to an unhealthy moral atmosphere."

The economic effect of malaria on industry is well recognised by employers of labour in this country, and a great improvement in health has resulted from the adoption of anti-malaria measures in many parts of India, notably in the case of tea estates in Assam, Northern Bengal and Southern India. Business men are quick to realize the economic loss due to this disease, but it is sometimes difficult to persuade municipalities that it will actually pay them to spend money on anti-malaria measures. When, however, the loss in wages, the dislocation of work, the cost of providing hospitals and medical treatment for the sick are taken into account, the resulting total is likely to reach startling proportions. In Bombay, for instance, it was calculated in 1928, that the average annual loss to the community on account of malaria amounted to at least Rs. 50 lakhs (Covell, 1928).

Whilst it is sometimes possible to induce local health authorities to provide funds immediately after the evil effects of malaria have been demonstrated to them by the occurrence of a virulent epidemic, it is often difficult to persuade them to continue these measures, after the epidemic has subsided. It is natural that when the incidence of the disease falls, there should be a tendency to cut down expenditure on anti-malaria measures, particularly in times of financial stringency. There are many instances on record where the very success of anti-malaria campaigns, by removing the stimulus to action, has led to the reduction of expenditure on control measures to a level at which the scheme can no longer operate effectively, resulting in a disastrous recrudescence of the disease.

The ravages of malaria exert a profound effect on agriculture in all countries where the disease is endemic, and in India in particular the welfare of the people is dependent in great measure on

agricultural prosperity. As has been already stated, there are many examples where it has been impossible to develop tracts of fertile country solely on account of the widespread prevalence of malaria in its most severe form. For instance, in the Terai area of the United Provinces, the Government has for many years attempted to colonize the country with immigrants without success. Another area where similar conditions prevail, is the notorious Jeypore Hill tract, formerly in Madras Presidency and now included in the province of Orissa. Agricultural development has been likewise retarded in parts of the Central Provinces, Bengal and Madras, whilst the activities of the tea, coffee, rubber and other plantations in many parts of India have been seriously hampered by the excessive amount of sickness prevalent among labour forces on the estates.

Moreover, in considering the effects of malaria on agriculture, there are other aspects to be considered besides the general diminution in efficiency and output of labour. Chief among these are the facts that the season of maximum malarial prevalence may fall at a time when labour is most needed for planting, cultivating or harvesting, and that a large turnover of labour is a very serious factor in many agricultural undertakings.

In addition to its serious effect on agriculture, malaria has frequently gravely hampered important engineering operations in India. A striking instance of this is the case of the Raipur-Vizianagram section of the Bengal-Nagpur Railway, the construction of which was delayed for forty years because the incidence of malaria among the survey parties was so intense that the first three were unable to complete their task, whilst the fourth succeeded only when every post in the party was duplicated. Other

instances where important enterprises have been seriously hampered are afforded by the epidemics of malaria which impeded the construction of the Alexandria Docks in Bombay and the Sarda Canal headworks in the United Provinces. Malaria has also formed a grave obstacle to the development of mining industries in many areas in India, which are frequently situated in foothill areas where malaria of a particularly virulent nature is commonly present. There are also many instances in which the disease has hindered communications and transport by the amount of sickness produced among the personnel employed on railways and in dockyards.

The profound effects of malaria on the social life of the community and of the individual are clearly manifest from the above brief review. The community, as a whole, has a reduced earning and productive power. The market value of land in malarious areas is lowered. The recruitment of labour is difficult, the quality of the work is deficient and the output lowered, often at a time when it is most urgently required. Industrial enterprises are hampered by epidemics of malaria among labour forces. The standard of education is lowered by the absence of children from school on account of sickness, whilst the effects of repeated attacks of malaria tend to produce a mental lassitude which frequently exerts a permanent effect on the life of the individual.

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BOOK REVIEW

Insect Pests of Burma—by C. C. GHOSH (Superintendent, Government Printing and Stationery, Burma, Rangoon, 1940). *Pp. i, ii+1-216 and Index i-xv. Rs. 7/8/- or 11s. 3d.*

The title of the work is somewhat misleading, as in addition to insect pests other animal pests such as grubs, ticks, mice and rats are included in this work—though this is explained in the Introduction, it would have been better if some name similar to that of T. B. Fletcher's "Some South Indian Insects and other Animals of Importance considered especially from an economic point of view" had been adopted. The work is planned on Lefroy's well-known work, *Indian Insect Life*, published in 1909, and as the author says, most of the coloured illustrations reproduced in the work are taken from Lefroy's work, the *Entomological Memoirs* of the Imperial Department of Agriculture, Pusa, and the *Proceedings* of the 2nd-5th Entomological Meetings.

The work is divided into two main parts. In the first part general facts about insect life and pests, food and feeding, habitat, life cycle, hibernation and aestivation, behaviour of insects, classification, how insects affect man, enemies of insects and means of protection against them, beneficial animals and insects, prevention and control of damage by insects, application of insecticides, biological control, etc., are briefly dealt with in some 42 pages. In the second part the pests are classified according to the plants on which they are found. These include pests of all important crops, vegetables, garden plants, plantation crops, fruit trees, palms, and finally pests in houses and stores. In each case a general description and a coloured or halftone illustration of the pest is published, and measures for dealing with the pest are also outlined. A glossary of the Burmese terms is appended at the end.

The work should be useful for the general public of Burma who have very little knowledge about insects, and the large number of illustrations should prove of special value in this connection.

The *sine-quanon* for the control of insect pests is a knowledge of the various species and their life histories, not only by the entomologists but also by the general public. It is hoped that this work will play an important part in bringing home to the Burmese public the importance of insects in the economy of life, and enable them to distinguish at least some of the more destructive species.

B. P.

Statistical Calculations for Beginners—by E. G. CHAMBERS, Assistant Director of Research in Industrial Psychology, Cambridge. Published by Cambridge University Press, 1940. *Pp. viii+110. Price 7s. 6d. net.*

The small volume is intended for students without mathematical equipment, who have to perform calculations involved in the ordinary statistical methods. The few chapters are devoted to averages, dispersion, normal distribution, significance of mean and difference between means, correlation, regression and goodness of fit, etc. The aim of the author has been to acquaint his readers with the uses and applications of the common statistical methods for the examination of data collected from different branches of science. Only that much of theoretical aspects of the subject has been included as would enable the readers to understand the implication of the various methods described. The procedure followed by the author in providing worked out examples illustrating each method and abundant similar exercises to be independently worked out will prove to be useful to those who have to examine statistically similar data. The book may be recommended as one which will teach the student not only how to make use of the commoner methods of statistics but also will give them some understanding of the specific purpose of each statistical method he learns to use and of the scope of and the assumptions underlying the use of such methods.

S. D.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

Vernalization of Rice

A preliminary investigation was designed to study the effect of vernalizing rice seeds in different temperatures. A highland *Aus* variety, Dhairal, was germinated in petrydishes at 29.5°C with 55–60% water per dry weight to ensure just the emergence of the embryo. The germinated seeds were vernalized in different sets to one of the following temperatures:— $0^{\circ} \pm 1^{\circ}\text{C}$ (V_1, V_2), $11^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (V_3, V_4), $29.5^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$ (V_5, V_6) for 15 and 10 days respectively. Water was sprayed with an atomiser according to requirement to keep them in normal condition. Considerable care was taken to avoid infections.

Seeds of these six treatments with a control set all in equal stage of germination were sown in earthenware pots. A weekly count of tillers, measurement of plant height, and the number of leaves including the topmost mature leaf were taken; the date of emergence of ears, and finally the dry weight of grains were also noted. So far as the number of tillers are concerned a peculiarity observed was the production of a large number of sterile tillers in V_1 set. The percentage of fertile to total tillers in V_1 is 28.05% as compared with the control of 43.04%. Vernalization at 11°C (V_3, V_4) was definitely detrimental to tiller production for both the treatments. The rate of growth in height and the number of mature leaves on the main tiller varied in different treatments from time to time insignificantly.

The average time of ear emergence, total number of ears and the average dry weight of grains in gms. are given in the table with the base—Control=O.

Regarding average time of ear emergence the different treatments responded in the order of $V_5; V_6; V_2; V_4; V_1; C$, the range of statistical insignificance is denoted by bars above or below. In V_5 the emergence was practically over when it began in the control. The average total number of ears were in the order of $V_5; V_6; C; V_3; V_4; V_2; V_1$; and the yield of grains $V_5; V_6; C; V_1; V_3; V_2$; V_4 . The yield of grains were thus detrimental on

exposures both at 0°C and 11°C whereas the exposure at 29.5°C for both 15 and 10 days tended towards improvement. This leads one to conclude that vernalization at 29.5°C leads to improvement so far as earliness is concerned without any loss in yield.

Control=O

Treatments.		Average time of ear emergence.	Total number of ears.	Dry wt. of grains in gms.
0°C	—15 days (V_1)	— 0.01	—1.53	—3.36
0°C	—10 days (V_2)	— 2.56	—1.33	—4.08
11°C	—15 days (V_3)	— 4.71	—1.00	—4.28
11°C	—10 days (V_4)	— 0.10	—1.33	—4.78
29.5°C	—15 days (V_5)	—12.06	+1.67	+2.46
29.5°C	—10 days (V_6)	— .43	+0.50	+1.61

The experiment was undertaken as in certain parts of Bengal, considerable rice crop of *Aus* paddy is damaged due to the incidence of early flood, submerging the whole crop when it is about to ripe. Since there is no strain in the existing *Aus* varieties whose life period is less than 90 days, an approach to the problem may be sought in reducing the life period of the existing high yielding early strains by the technique of vernalization. Though the results obtained in this experiment are not exhaustive enough for any definite conclusion, yet it shows that rice responds to the treatments of vernalization and the beneficial effect is to be sought by vernalizing at higher temperatures.

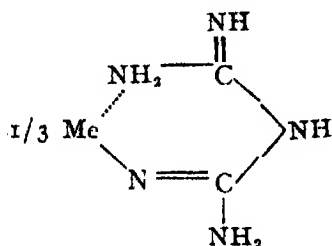
S. Hedayetullah
Nirad Kumar Sen

Botanical Section,
Central Agricultural Experimental Station,
Dacca, 14-3-1941.

A New Type of Polynuclear Metal Complex

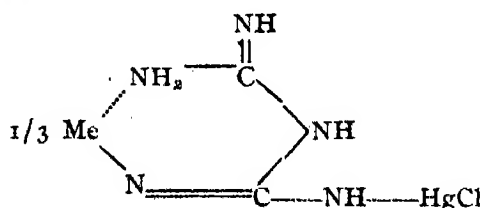
Various types of polynuclear metal complexes with two or more central atoms of one and the same metal, bridged together by one, two or three co-ordinating groups, are described in literature; but the formation of a polynuclear complex with two different central atoms is till now believed to be improbable, if not altogether impossible.

It was already shown by one of us¹ that in chromium or cobaltic trisbiguanidine one of the amino groups of each of the co-ordinated biguanide molecule remains free for further co-ordination, whereas both the primary and secondary valencies of the tervalent metal atom are completely saturated as in an inner metallic complex.

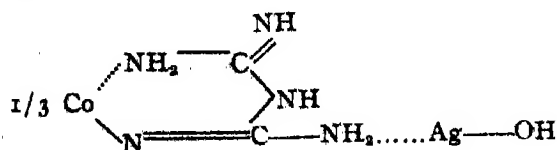


This makes the chromic or cobaltic trisbiguanidine behave as an organic amine, combining with water and acids to form hydroxides and salts.

We have recently found that cobaltic or chromium trisbiguanidinium hydroxide reacts with mercuric chloride to form compounds of the *infusible white precipitate* type:



Similarly cobaltic trisbiguanidinium hydroxide gives with silver nitrate an insoluble precipitate of the following structure:



This latter may be regarded as a polynuclear complex with two different central atoms, Co and Ag, in one and the same molecule; the bridge between the two atoms in this case is supplied not by a single co-ordinating group, but by a part of a

molecule. The co-ordination number of silver here is, as usual, two.

P. Rây
S. Siddhanta

Inorganic Chemistry Laboratory,
University College of Science,
Calcutta, 31-3-1941.

¹ Ray and Saha, *Jour. Ind. Chem. Soc.*, 14, 670, 1937

Submerged Forest in Calcutta

Several trunks of trees have been recently excavated from a depth of nearly 30 feet from the surface (below the upper peat-layer of Calcutta soil), in the eastern extensions of the Dhakuria lake in Calcutta. They were found erect *in situ* with portions of the basal roots still intact. The position of these stumps as well as several others excavated in other parts of the lake, during similar excavation work in the past¹, affords unmistakable evidence of the subsidence of an extensive forest which once existed in this area. The forest has been gradually buried underground, by the slow and gradual silting up of an area that was once the delta of the Ganges.

It is estimated, that this gradual process of silting up must have approximately taken about 2000 years.



Photo of an excavated trunk *in situ*.
x shows the trunk.

The plants are identified as *Heritiera Fomes* Buch (=H. minor Lam)² commonly known in

Bengali as *Sundri*, from which the name of the Sundribans forest is derived and which grow in abundance on the muddy flats of the Ganges delta.

They are now distributed throughout the reserved forests of the Sundribans (Khulna-Bagerhat forests), along the Chittagong tidal tracts and in the tidal forests of Burma and form the characteristic vegetation of the littoral forests.

The range of occurrence of these trees is from 2 to about 10 feet below the high water mark. They grow in mud and their roots (pneumatophores) are exposed to the air for at least several hours after each tide.

With the kind permission of the chairman of the Calcutta Improvement Trust, these submerged underground tree trunks are now being investigated by me.

Previous records of such occurrence are by Blanford³ who mentions the occurrence of *Sundri* *in situ* at a depth of 30 ft. from an excavated tank at Sealdah.

Oldham⁴ records the occurrence of *Heritiera littoralis* Dry, in similar boring operations conducted in Fort William. This species, however, does not occur⁵ at present in the Sundribans, but is restricted to the delta forests of Burma, west coast of India and the sea coasts of the Andamans.

The occurrence of several other plants^{6, 4} from the peat-soil round about Calcutta, along with the *Sundri* furnishes us with a very interesting history of the palaeo-geography of the city of Calcutta and its suburbs.

A. K. Ghosh

Botanical Laboratory,
Calcutta University,
Calcutta, 7-3-1941.

¹ Fox, *Mem. Geo. Sur. Ind.*, LVIII, 1931.

² Pearson and Brown—*Commercial Timbers of India*, 1937.

³ Blanford, *Jour. As. Soc., Bengal*, XXXIII, 1865.

⁴ Oldham, *Manual of the Geology of India*, 1893.

⁵ Prain, *Rec. Bot. Sur. Ind.*, 2, 5, 1903.

⁶ Hooker, *Himalayan Journals*, 1854.

Voltage Gain of Low Frequency Amplifiers with Negative Resistance

The total voltage gain of low frequency valve amplifiers is often found to be sensibly less^{1, 2, 3} than the value calculated from the associated circuit and

tube constants. A close analysis of the circuit of a resistance-capacity coupled amplifier has shown that the attenuation of the voltage transferred from one stage to the other is mainly due to the various inter-valve coupling components. It has been found that out of these components the grid resistance only can be varied at will in order to partly compensate the loss of voltage incurred without causing any serious effect on the working conditions of the apparatus. It has been further shown that the minimum loss of voltage can be obtained with negative resistance in the grid circuit.

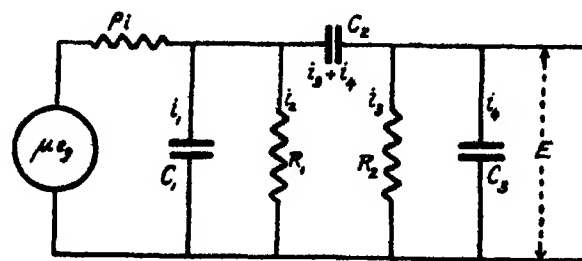


Fig. 1.

Fig. 1 represents the equivalent circuit of a low frequency resistance-capacity coupled amplifier consisting of two valves. e_g is the input potential applied to the grid of the first valve of internal resistance ρ and μ is the amplification factor of the valve. E is the amplified voltage delivered to the grid of the second valve. C_1 and C_3 represent the inter-electrode capacities of the first and second valve respectively. R_1 indicates the plate load resistance and R_2 represents the combination of the grid-leak and input resistance of the second valve.

If ω be the angular frequency of the input e.m.f. we can write the circuit equations with the notations of currents in different branches shown in fig. 1 as the following.

$$i = i_1 + i_2 + i_3 + i_4 \quad \dots \quad (1)$$

$$\mu e_g = \rho i + i_1/j\omega C_1 \quad \dots \quad (2)$$

$$R_1 i_2 = i_1/j\omega C_1 \quad \dots \quad (3)$$

$$R_1 i_2 = (i_3 + i_4) \left(\frac{1}{j\omega C_2} \right) R_2 i_3 \quad \dots \quad (4)$$

$$R_2 i_3 = i_4/j\omega C_3 \quad \dots \quad (5)$$

From the above equations it can be shown that the absolute value of voltage output will be given by,

$$(E) = \frac{\mu e_g}{\sqrt{\left(A + \frac{B}{R_1}\right)^2 + \left(C - \frac{D}{R_2}\right)^2}} \quad \dots \quad (6)$$

where
$$A = 1 + \frac{C_3}{C_1} + \frac{\rho}{R_1} + \frac{\rho C_3}{R_1 C_1},$$

$$B = \frac{\rho C_1}{C_3} + \rho,$$

$$C = \frac{\omega \rho C_1 C_3}{C_1} + \omega C_1 \rho + \omega C_3 \rho,$$

and
$$D = \frac{\rho}{\omega R_1 C_3} + \frac{1}{\omega C_3}.$$

From equation (6) we get the condition for maximum transfer of energy from plate of the first valve to the grid of the second, as

$$R_2 = \frac{B^2 + D^2}{DC - AB} \quad \dots \dots \dots (7)$$

Equation (7) shows that the value of R_2 is negative as DC is always less than AB.

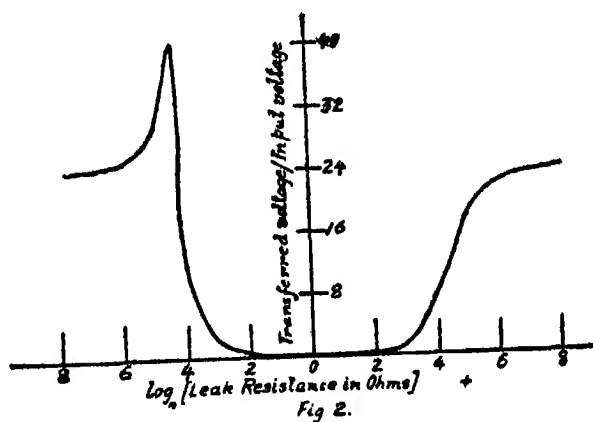


Fig. 2 shows a typical curve depicting the mode of variation of the overall amplification in terms of the ratio between the input voltage and the transferred voltage measured at the grid of the second valve, when the leak resistance is altered gradually from positive to negative values, as calculated from equation (6).

The above variation of the amplification and the condition of minimum loss of energy have been experimentally verified by using a dynatron valve as negative resistance in the leak R_2 in fig. 1. The details of the observations will appear very shortly in the *Indian Journal of Physics*.

This paper was read in the Indian Science Congress held at Benares and the authors have great pleasure to express their sincere thanks to Prof. S. K. Mitra of the University of Calcutta for his very

helpful discussions and suggestions which he made during his stay in Benares at that time.

Wireless Section,
Physics Department,
Benares Hindu University,
Benares, 15-3-1941.

S. S. Banerjee
A. S. Rao

¹ F. W. Schor, *Proc. Inst. Rad. Eng.*, 20, 87, 1932.

² D. G. C. Luck, *Proc. Inst. Rad. Eng.*, 20, 1401, 1932.

³ W. F. Curtis, *Proc. Inst. Rad. Eng.*, 24, 1230, 1936.

Theory of the Variation of the Resistance of a Thermionic Valve with Frequency

Mitra and Sil¹ worked out a theory of the variation of the internal resistance of a thermionic valve with frequency. Assuming a Maxwellian distribution of velocity of the electrons inside the valve they calculated the time of flight of the electrons making certain simplifying assumptions and approximately obtained the values of the conductivity of the valve for different frequencies. These values calculated on their theory agreed well with those obtained by them experimentally in the high frequency range. Some measurements of the internal resistance of a valve were subsequently carried out by Kameswar Rao² in this laboratory over a wide range of frequencies. Starting from a high frequency it was found in substantial agreement with Mitra and Sil's results, that the internal resistance of a valve decreased gradually with the decrease of frequency. With further decrease of frequency, however, the internal resistance of the valve was found to increase gradually. This latter result of Rao which has also been recently confirmed by a different method cannot be explained according to Mitra and Sil's theory.

The object of the present note is to explain the observed variation of the internal resistance of a thermionic valve with frequency over a wide range. While accepting Mitra and Sil's fundamental ideas as regards the conductivity of the valve due to the convection current, we have taken into account the conductivity arising from the displacement currents in interpreting the experimental results on the internal resistance of a thermionic valve.

Mitra and Sil assumed that the electrons emitted from the cathode have a Maxwellian distribution of velocity. On applying an alternating field, the electrons are set into oscillatory motion which is superimposed on their original Maxwellian velocity.

It is possible that under the influence of this field, for one half of the alternation, the electrons will be able to strike the anode of the valve giving up both their kinetic energy and charges. For just reaching the anode under the applied fields of frequency $\left(\frac{1}{2T}\right)$ at the end of the interval T , there must be a critical velocity v_0 with which the electrons must be moving initially. All the electrons which have been moving with velocities greater than this critical velocity v_0 at the instant when the field has begun to act would also reach the anode within the interval T . The conductivity for a particular frequency $f = \frac{1}{2T}$ would then be proportional to $\left(\frac{n \cdot T}{T}\right)$ where n is the number of electrons having velocities within the range v_0 to ∞ and reaching the anode surface within the time interval T .

If x is the distance between the anode and the cathode and f the frequency of the applied field, then the conductivity of the electronic medium, for a given electron concentration and temperature can be shown to be:

$$\sigma_0 = K \cdot e^{-ax^2f^2} \quad (1), \text{ where } K \text{ and } a \text{ are constants.}$$

This conductivity arises out of the convection current inside the valve.

It is evident from (1) that this conductivity term would decrease gradually with the increase of frequency. This conclusion is based on the supposition that all the electrons in the inter-electrode space move *only in the positive direction, i.e., towards the anode surface*. This supposition is however correct in the experiments where the anode is given a high voltage with respect to the cathode.

There is however an important factor which should be taken into consideration. In the Maxwellian distribution of velocity, there must be a lower limit u_0 which is the velocity component normal to the surface necessary for the electrons to escape from the cathode. In that case it is evident that the number of electrons reaching the anode will assume a constant value when the frequency $\left(\frac{1}{2T}\right)$ is reduced to such an extent that the initial velocity of the electrons which would carry them to the anode in time T becomes the same as u_0 . According to this idea, therefore, the conductivity of the valve would remain constant for frequencies lower than a certain value corresponding to the limiting velocity u_0 of the electrons. This limiting velocity would be given by $\frac{e\phi}{300} = \frac{1}{2}mu_0^2$, where ϕ is the work-function (in volts) of the material of the cathode and e and m are the charge and mass of an electron. The frequency

corresponding to this limiting velocity u_0 would then be given by $f_0 = \frac{1}{10x} \sqrt{\frac{e\phi}{6m}} \dots (2)$, where the inter-electrode distance x is equal to $u_0/2f_0$.

The conductivity due to the displacement currents in the medium can also be determined. It can be shown that this would be given by $\sigma_d = \frac{\epsilon \cdot \omega}{4\pi} \dots (3)$, where ϵ is the dielectric constant of the medium and ω the angular frequency of the applied field.

We know, however, that the dielectric constant ϵ of the electronic medium increases with the increase of frequency. It was shown by Khastgir and Choudhury³ that the value of $(1 - \epsilon)$ varied inversely as the square of frequency. Even if ϵ were regarded as constant, the conductivity σ_d due to the displacement currents would steadily increase with the increase of frequency. When the frequency exceeds the limit defined by (2), it should be remembered that the conductivity due to the convection current would no longer remain constant but would begin to decrease steadily with further increase of frequency. The experimental results on the conductivity of a valve for a wide range of frequencies can therefore be explained.

A fuller exposition will be published elsewhere.

S. R. Khastgir

Physics Laboratory,
Dacca University,
Dacca, 3-3-1941.

¹ Mitra and Sil, *Phil. Mag.* 13, 1081, 1932.

² Kameswar Rao, *Ind. Jour. Phys.*, June, 1940.

³ Khastgir and Choudhury, *Ind. Jour. Phys.*, June, 1940.

Storage of Vitamin A in Liver under different conditions of Protein and Carbohydrate intake

Experiments were devised to ascertain what influence is exerted by the protein and carbohydrate content of the diet on vitamin-A storage in the body. They were carried out at two stages. At the first stage, 14 young rats (body weight—30-40 grammes) were taken. Two of them were killed and the vitamin A content of their whole liver was found to be 12.6 and 18.0 I. U. As all these rats were on the same diet and were of nearly the same weight previous to this experiment, the vitamin A content of their livers at the commencement of this experiment was not expected to differ greatly from these figures, viz., 12.6 to 18.0 I.U. The remaining animals were

divided into 3 groups; each group included 4 rats and was given a different diet. Table I gives the composition of the diet given to each group and the vitamin A content of the whole liver at the end of the period of the experiment. The animals were kept on these diets for 37 days and each was daily receiving in addition 100 I.U. vitamin A from Crookes' halibut liver oil (the daily requirement of vitamin A of rats is 10 to 15 I.U.)

At the 2nd stage the animals were given slightly different diets, olive oil having been added to the diet of one group. The procedure adopted was the same as at the 1st stage. Two rats were killed and the vitamin A content of their whole liver was found to lie between 12 and 20 I.U., *i.e.*, nearly the same as in the case of rats killed before the experimental diet was given at the 1st stage. The remaining rats (weight—30 to 40 gms) were divided into 4 groups and were put on diets, different for each group, for 56 days, each animal getting daily 100 I.U. of vitamin A, as at the 1st stage. The animals were then killed and the vitamin A content of their whole liver was determined by the usual colorimetric and spectrophotometric methods. Table II gives the composition of the different diets and the vitamin A content of the whole liver of each animal at the end of the experiment.

As the animals were put on the experimental diet for a longer period at the 2nd stage than at the 1st stage, the former had generally a greater amount of vitamin A in their liver than the latter. It will be observed that the addition of fat to a low protein diet has not appreciably helped the storage of vitamin A in liver (*cf.* A and D in table II). The difference in composition between D, in table II and B in table I is mainly with regard to protein and fat. It is the increase in the protein content of the diet and not the addition of fat, that has considerably increased the vitamin A storage in liver. It is evident from B and C in table I and B and C in table II that an excess of protein in the diet has not led to a corresponding increase in the deposition of vitamin A in liver. On analysing these tables it becomes abundantly clear that if the protein content of the diet be much below the average requirement, the vitamin A storage in liver is much lower even when sufficient fat is included in the diet than when the protein intake is normal. Thus the excess of carbohydrate intake at the expense of protein, which is the prevailing habit amongst the poorer Bengalees prevents them from deriving sufficient benefit from their vitamin A intake in any form. This fact is to be taken into consideration in any measure of reform of the diet of poor Bengalees based solely on liberal supply of vitamin-A rich liver oils, such as cod liver oil, shark liver oil or halibut liver oil, etc.

Details of this experiment will be published elsewhere.

INFLUENCE OF PROTEIN CARBOHYDRATE RATIO IN THE DIET ON THE STORAGE OF VITAMIN A IN LIVER.

TABLE I

Groups of animals.	Composition of the diet.	No. of the Experimental animals.	Vitamin A content of the whole liver in I.U.
A	Casein .. 8%	1st	84.0
	Dextrin .. 80%	2nd	70.0
	Yeast .. 8%	3rd	83.0
	Salt Mixture 4%	4th	62.0
B	Casein .. 18%	1st	930.0
	Dextrin .. 70%	2nd	1200.0
	Yeast .. 8%	3rd	840.0
	Salts .. 4%	4th	920.0
C	Casein .. 65%	1st	1260.0
	Dextrin .. 23%	2nd	1200.0
	Yeast .. 8%	3rd	1010.0
	Salts .. 4%	4th	(died within 10 days, liver not analysed)

TABLE II

Groups of animals.	Composition of the diets.	No. of the animals.	Vitamin A content of the whole liver in I.U.
A	Casein .. 5%	1st	133.0
	Dextrin .. 83%	2nd	120.0
	Yeast .. 8%	3rd	180.0
	Salts .. 4%		
B	Casein .. 25%	1st	1620.0
	Dextrin .. 63%	2nd	867.0
	Yeast .. 8%	3rd	1060.0
	Salts .. 4%		
C	Casein .. 65%	1st	1710.0
	Dextrin .. 23%	2nd	1520.0
	Yeast .. 8%		
	Salts .. 4%		
D	Casein .. 5%	1st	162.0
	Dextrin .. 73%		
	Fat (olive oil) 10%		
	Yeast .. 8%	2nd	270.0
	Salts .. 4%		

This investigation was carried out with the funds of the Indian Research Fund Association.

Physiological Laboratory, N. M. Basu
Presidency College, N. K. De
Calcutta, 7-4-1941.

A Correction

I am indebted to Dr C. Chandrasekhar, assistant professor of vital statistics, All India Institute of Hygiene, Calcutta, for pointing out to me in a private communication that the sampling distribution on the non-null hypothesis of B^2/W^2 which I announced in *SCIENCE AND CULTURE* of March had already been worked out by Dr P. C. Tang and published in *Statistical Research Memoirs*, Vol. 2, December, 1938. I came up against this problem incidentally in course of an investigation of a more general character, the results of which will be shortly announced in *SCIENCE AND CULTURE*. The solution of the particular problem which is a degenerate case of the general problem came out so very simply by geometrical methods that I myself was wondering whether the result might not be known. But I could not spot it. On receipt of Dr Chandrasekhar's letter I looked up that journal and paper and found that Dr Tang's result is substantially the same as mine though formally different. His analytical and algebraic method of derivation is necessarily much longer than the geometrical method which I used in my derivation.

S. N. Roy

Statistical Laboratory,
Presidency College,
Calcutta, 21-3-1941.

Fossil Pollen in the Tertiary Rocks of Assam

The application of Raistrick's¹ method of extracting microspores from carbonaceous shale of Tertiary (Eocene)² age from Laitringow, near



Photomicrograph of the fossil pollen 320.

Cherrapunji (Assam), has revealed that these shales are rich in pollen in a good state of preservation.

The examination of the material is now in progress and it is hoped to publish a detailed report shortly. In the meantime, it may be of interest to record that these spores are provided with bladder-like extensions of the exine, agreeing in size and form with those of recent *Podocarpinae*³. Winged pollen grains have been previously recorded from India in Lower Gondwana rocks of Salt range, Punjab, and have been referred to Seward's *Pityosporites*⁴ which is suspected to be a pollen grain of *Glossopteris*.

A. K. Ghosh

Botanical Laboratory,
Calcutta University,
Calcutta, 7-3-1941.

¹ Raistrick—*Trans. Inst. Min. Engineers*, 88, 142, 1934.

² Ghosh—*Rec. G. S. I. LXXV* (Professional paper 4) 1940.

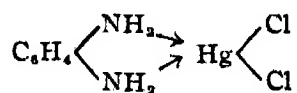
³ Wodehouse—*Pollen Grains*, 1935.

⁴ Virkki—*Proc. Ind. Acad. Sc.*, 6, 6, 1937.

Co-ordinated Mercury Compounds with Diamines and their Salts

Orthophenylene diamine forms with mercuric salts (chloride, bromide, nitrate and perchlorate) co-ordinated compounds in which one molecule of the diamine combines with a molecule of the mercuric salt. If the reaction is carried out in dry alcoholic solutions, mercuric chloride and mercuric bromide yield almost colourless precipitates with the diamine, the nitrate gives light brown and the perchlorate deep brown products. Orthophenylene diamino mercuric salts are all soluble in acetone. They also dissolve in water, alcohol, ether, aniline, methyl aniline, dimethyl aniline, chloroform, xylene, pyridine, piperidine and other organic solvents. But with none of these solvents they form addition compounds. The complex salts easily decompose on heating, the perchlorate decomposes with explosion. A point of special interest arises from the discovery of two different forms of the complex chloride. Crystallised from water, alcohol, aniline or chloroform, orthophenylene diamino mercuric chloride melts at 139°—140°. When dissolved in acetone, it gives a yellow solution which on evaporation at first forms a semi-solid mass that quickly changes to yellow powder melting at 110°. It is not an addition compound of acetone but pure orthophenylene diamino mercuric chloride of the formula $[\text{HgC}_6\text{H}_4(\text{NH}_2)_2]\text{Cl}_2$. On treatment

with hot water this latter form readily changes to the other variety. With monamines *cis-trans* isomerism would have been possible. But with a chelating diamine, there is no alternative to a *cis*-arrangement. One of the two forms of *o*-phenylene diamino mercuric chloride must be a *cis*-compound and may be represented as



The other form, possibly the unstable one, may be a polymer of this. The question is being studied. As with orthophenylene diamine, mercuric salts form co-ordinated compounds with meta and para phenylene diamines and 1:8 naphthalene diamine.

Hydrochlorides and hydrobromides of the diamines mentioned above also unite with mercuric chloride and mercuric bromide respectively, one molecule of the diamine in each case being co-ordinated to a molecule of the mercuric salt. The mercury compounds prepared with the diamine salts are more or less soluble in water. In many complex benzidine compounds of mercury previously prepared, the co-ordination number of mercury exceeded two by the addition of amines like pyridine, piperidine and aniline. Two remarkable examples¹ of 4-co-ordinated mercury compounds obtained being benzidine-piperidine mercuric chloride and benzidine piperidine mercuric bromide. But by such addenda, the co-ordination valency of mercury has not yet been found to exceed two in any compound described here.

Chemical Laboratory,
Presidency College,
Calcutta 5-4-1941.

Kanai Lal Mondal

¹ SCIENCE AND CULTURE, 5, 719, 1939-40.

Crystalline Haemolysin from Cobra (*Naja Naja*) Venom

Slotta and Fraenkel-Conrat¹ reported that they have prepared a crystalline protein, which contains the neurotoxin and the haemolysin but not the coagulating principle, from *crotalus-t-terrificus* venom. They claim that in the case of *crotalus-t-terrificus* venom the toxic substance has got both haemolytic and neurotoxic properties. But in the case of cobra (*Naja Naja*) venom it has been shown by Ghosh and De² and De³ that they are two different constituents

of cobra venom and the toxicity is mainly due to the neurotoxin fraction of the venom. In a previous communication³ by the present author it was reported that the haemolysin fraction could be purified eleven times with respect to crude cobra venom. The present note gives a method of purifying it further and obtain it in a crystalline form.

2gm. of cobra venom was dissolved in 100 c.c. water and the reaction of the solution was adjusted to pH 3.0 by the addition of 3N sulphuric acid. To this solution 15 gms. of sodium chloride was gradually added and the mixture kept in the thermostat at 37°C for 20 minutes. The precipitate which contained the haemolysin was filtered and redissolved in 50 c.c. of water. After adjusting the reaction of the solution to pH 4.2, 5 gm sodium chloride was gradually added to precipitate some of the inactive proteins of the venom. The mixture was filtered after some time and the filtrate, which contained the active principle, was adjusted to pH 2.8—3.0 and the active principle precipitated by the addition of 2 gm. more sodium chloride. The active precipitate was filtered under suction to remove the maximum amount of liquid. The precipitate was then dissolved in 20 c.c. of water and adjusted to pH 2.8—3.0 and precipitated by the gradual addition of 5.2 gm. of ammonium sulphate. The precipitate which contained the haemolysin fraction was filtered as before and dissolved in 10 c.c. of 0.2M acetate buffer of pH 5.6 and treated with 10 c.c. suspension of Alumina C₇ (Al₂O₃ = 396 mg.) and shaken for 30 minutes in the shaker. Alumina C₇ absorbed major portion of the inactive proteins and very little amount of haemolysin. The supernatant liquid separated from the alumina by centrifuging was treated with 5.2 gm. ammonium sulphate and the precipitate formed was found to be inactive. The precipitate was removed by filtration under suction, and to the filtrate more ammonium sulphate was gradually added till it has reached 0.6 saturation with respect to ammonium sulphate. A suspension of needle-shaped crystals were obtained. After being kept at room temperature for one hour, the crystals were centrifuged out. The crystals were dissolved in 4 c.c. of 0.2M acetate buffer of pH 6.0 and cooled to 10°C and saturated solution of ammonium sulphate was gradually added till the first formation of crystals. The mixture was brought to room temperature. Crystallization was complete within 2 hours. These crystals has 2.94 per cent protein and 52 per cent haemolysin content with respect to crude cobra venom. On recrystallisation no further increase in activity was observed. The purity of these crystals were determined by their solubility in ammonium sulphate solution according to the method of Kunitz and Northrop⁴ and they were found to be homogeneous.

My best thanks are due to Dr B. N. Ghosh for his keen interest and advice and to the Indian Research Fund Association for financing the work.

Department of Applied Chemistry,
University College of Science, S. S. De
Calcutta. 7-4-1941.

¹ Slotta, K. H. and Fraenkel Conrat, H., *Nature*, 142, 213, 1938.

² Ghosh, B. N. and De, S. S., *Ind. Jour. Med. Res.*, 25, 779, 1938.

³ De, S. S., *Ibid.*, 27, 531, 1939.

⁴ Kunitz and Northrop, *Cold Spring Harbour Symposia On Quantitative Biology* (Cold Spring Harbour), 6, 325, 1938.

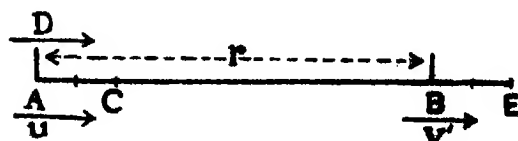
Towards the Law of Composition of Velocities in the Theory of Relativity.

The well-known procedure of deriving the law of composition of velocities in the Theory of Relativity is given in Einstein's paper, 'On the Electrodynamics of moving bodies', 1905.

Recently, however, it seemed to me that the same law may be attained by a novel and more direct method. In this paper it is intended to present that method.

We make no definitive and specific restrictions as to relative velocity, which involves the law of composition of velocities, except that it is some function of the corresponding "individual" velocities. And in the following considerations we shall maintain a formal distinction between relative velocity as such and the "individual" velocities concerned.

Let there be two bodies A and B with dispositions and velocities as shown in figure 1; a "messenger" travelling with velocity, D, completes



(Fig. 1)

a to-and-fro journey from A to B and back. We assume a "fixed" Galilean frame of reference K, and calculate from it the time taken in this journey and the distance, CE, the two bodies stand apart at the termination of the journey.

We obtain the time to be

$$\frac{r}{D-v'} + \frac{r + \frac{r}{D-v'} v' - \frac{r}{D-v'} u}{D+u} = \frac{2Dr}{(D-v')(D+u)} \quad (1)$$

and the particular distance to be

$$r + \frac{r}{D-v'} v' - \frac{r}{D-v'} u + \frac{r + \frac{r}{D-v'} v' - \frac{r}{D-v'} u}{D+u} v' \\ = \frac{r + \frac{r}{D-v'} v' - \frac{r}{D-v'} u}{D+u} = \frac{r(D-u)(D+v')}{(D+u)(D-v')} \quad (2)$$

We now proceed to evaluate the time and the particular distance, from the body A (or B), regarding it as at rest, system K'.

In accordance with our reflections on relative velocity we may designate the relative velocities involved as (D-u) f (D, u), (D+u) f (-D, u) and (v'-u) f (v', u).

We obtain the time taken to be

$$\frac{r}{(D-u)f(D, u) - (v'-u)f(v', u)} \\ + \frac{r + \frac{r}{(D-u)f(D, u) - (v'-u)f(v', u)} (v'-u)f(v', u)}{(D+u)f(-D, u)} \\ = \frac{r(D+u)f(-D, u) + r(D-u)f(D, u)}{(D+u)f(-D, u) \{ (D-u)f(D, u) - (v'-u)f(v', u) \}} \quad (1')$$

and the particular distance to be

$$r + \frac{r}{(D-u)f(D, u) - (v'-u)f(v', u)} (v'-u)f(v', u) \\ + \frac{r + \frac{r}{(D-u)f(D, u) - (v'-u)f(v', u)} (v'-u)f(v', u)}{(D+u)f(-D, u)} (v'-u)f(v', u) \\ = \frac{r(D-u)f(D, u) \{ (D+u)f(-D, u) + (v'-u)f(v', u) \}}{(D+u)f(-D, u) \{ (D-u)f(D, u) - (v'-u)f(v', u) \}} \quad (2')$$

(That, even in the system K', obtained by regarding the body A as at rest, the messenger's velocities on the outward and backward journeys are not taken to be the same is due to the fact that in this system the observer is confronted with the backward translation of his environment with a speed, u).

Now if the bodies A and B had not been in motion at all, these time and space values would merely be $\frac{2r}{D}$ and r .

Therefore we can legitimately hold that $v' - u$ varies with

$$\frac{r \frac{(D-u)(D+v')}{(D+u)(D-v')}}{2Dr} \dots \dots \dots 'a'$$

$$\frac{(D+u)(D-v')}{(D+u)(D-v')}$$

and that $(v' - u)f(v', u)$ or v , which we use to denote it, varies with

$$r \frac{(D-u)f(D, u) \{ (D+u)f(-D, u) + (v' - u)f(v', u) \}}{(D+u)f(-D, u) \{ (D-u)f(D, u) - (v' - u)f(v', u) \}}$$

$$r \frac{(D+u)f(-D, u) + (D-u)f(D, u)}{(D+u)f(-D, u) \{ (D-u)f(D, u) - (v' - u)f(v', u) \}} \dots \dots \dots 'b'$$

We have in $v' - u$ and $(v' - u)f(v', u)$ the values of similar entities which vary in the two system K and K' and vary with 'a' and 'b'.

Hence we can regard that $\frac{v}{v' - u} = \frac{(v' - u)f(v', u)}{(v' - u)}$

$$f(v', u) = \frac{r \frac{(D-u)f(D, u) \{ (D+u)f(-D, u) + (v' - u)f(v', u) \}}{(D+u)f(-D, u) \{ (D-u)f(D, u) - (v' - u)f(v', u) \}}}{r \frac{(D+u)f(-D, u) + (D-u)f(D, u)}{(D+u)f(-D, u) \{ (D-u)f(D, u) - (v' - u)f(v', u) \}}}$$

$$\times \frac{2Dr}{(D-v')(D+u)}$$

$$\times \frac{(D+v')(D-u)}{(D+u)(D-v')} \dots \dots \dots 'c'$$

Assuming that D is a universal constant of nature, we get

$$f(v', u) = 2D \times \frac{D \{ (D + (v' - u)f(v', u)) \}}{(D + v')(D - u)(D + D)} \text{ or}$$

$$f(v', u) = \frac{D^3}{D^3 - uv'} = \frac{1}{1 - \frac{uv'}{D^3}}$$

Therefore, $v = \frac{v' - u}{1 - \frac{uv'}{D^3}}$, which is the law of com-

position of velocities in the Theory of Relativity.

In conclusion I take the opportunity to express my debt and gratitude to Sir Shah Sulaiman.

A COROLLARY

We turn our attention to the expression 'c' in the form

$$f(v', u) = 2 \times \frac{(D+u)f(-D, u) / D + (v-u)f(v', u) / D}{\left(1 + \frac{v'}{D}\right) \left(1 - \frac{u}{D}\right) \left\{ \frac{(D+u)f(-D, u)}{(D-u)f(D, u)} + 1 \right\}}$$

In the following considerations we make use of no other extraneous idea besides the natural stipulation that for finite "individual" velocities the corresponding relative velocity is finite and that when the former tend towards unlimited values the latter also approaches infinity.

Obviously, there are two procedures by which this expression would yield $f(v', u) = 1$ i.e., the law of classical kinematics. Either we adopt the definitive basis of the Galileo-Newton scheme and put the fundamental velocities $(D \pm u)f(\mp D) = D \pm u$, or postulate that $D \rightarrow \infty$.

We thus reach the significant conclusion that the Galileo-Newton concepts of space and time and the possibility of the existence of infinite speeds are identical assumptions.

Jhang,
Punjab,
31-3-1941.

Zahur Husain

A Note on some Spotted Mica and a New Micro-analytical Method for Ferrous and Ferric Iron

It has been observed that some muscovite mica from Nellore contains some mineral imbedded in the substance which appears like fine spots scattered all over the surface of the mica. The inseparable nature of these fine spots from the main body of the mica due to their fineness presents the main difficulty in their proper analytical procedure. Qualitative micro-analysis of these spotted portions as well as the transparent clear portions of these spots revealed the fact that they differed in their iron contents only. Elements such as titanium, manganese etc., were found to be absent—a fact that led to believe that they might consist of iron ores like hematite or magnetite. It was found that both the ferrous and ferric iron were present and therefore it was thought that they might consist of crystallised magnetite imbedded between the thin films of mica during the time of their geological formation.

The spotted as well as the colourless portions were then examined for their magnetic susceptibilities by the Curie balance. When compared it was found that the spotted portions were highly paramagnetic while the clear ones were only feebly so.

To prove definitely that these spots were magnetite in nature it was found necessary to find out the ratio between the ferrous and ferric iron in these spots. The ratio was to be found out in the same sample and for this purpose a special modified micro-method has been worked out. The ore was dissolved in a mixture of hydrochloric and hydrofluoric acid,

the excess of hydrofluoric acid was removed by the addition of boric acid as proposed by Barnebey¹ and the ferrous iron was titrated with standard ceric sulphate (N/100). Ferrous-*o*-phenanthroline was used as internal indicator for which indicator correction was necessary. The whole operation was performed in an atmosphere of pure carbon dioxide. Phenylanthranilic acid was found to be a more convenient indicator, for it required no indicator correction. This titrated solution was again titrated for total iron by standard titanium chloride solution (N/150) when methylene blue was used as indicator and the proper indicator correction was applied. Unless 1 or 2 drops of sodium salicylate (10%) is added no sharp endpoint can be obtained at ordinary temperature. These difficulties can be obviated when phenylanthranilic acid is used as indicator in the ferrous iron titration since potassium thiocyanate solution (10%) which is the ordinary indicator for ferric iron can be used when ferrous-*o*-phenanthroline has not been used in the previous titration. The amount of total iron was obtained from the second titration—and the ferric iron was obtained by simple subtraction. The ratio of ferrous to total iron was found to be 1 : 3 which conclusively proved the magnetite nature of the spots. Microphotographs of these spots showed that they were beautiful crystallised mineral imbedded between

thin films of the mica. This micro-method can be conveniently used for the estimation of ferrous and ferric iron in the same solution. Quantities of iron present in minerals such as magnetite, hematite etc. can be accurately estimated up to the order of 10^{-3} mg. A. Benedith Pichler (1928) worked out a micro-method for the estimation of ferrous-iron—by the use of Redox indicator. In his method sharp endpoint can only be obtained when some ferric iron is added to the solution. This prevents the estimation of ferric iron in the same solution.

The above procedure is recommended when only small quantities of pure minerals are available for analysis. This method also settles conclusively the question raised by Hillibrand², and shows that after titrating the ferrous iron in hydrofluoric acid solution the total iron can be satisfactorily titrated with titanium chloride. Details will be published elsewhere.

My best thanks are due to Dr P. B. Sarkar for his helpful guidance and laboratory facilities.

Inorganic Chemical Laboratory,
University College of Science, Jyotirmoy Dasgupta.
Calcutta, 7-4-1941.

¹ *Jour. Amer. Chem. Soc.*, 37, 1481, 1916.

² *Applied Inorganic Analysis*, page 775.

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Fuel Economy Policy in India and Abroad

(Continued)

IN our last issue we broadly discussed the question of fuel economy in India and the various causes underlying the continuance of wasteful practices. The need for a proper State control of the fuel industries was emphasized specially in view of the effective measures adopted by other countries possessing far vaster fuel resources. We now propose to deal with the broad principles of national fuel policy determining the nature of supervision and the establishment of a central organisation for exercising such control. In the case of coal which is an irreplaceable mineral, the improvement of mining methods only cannot assure maximum life to it as most people appear to think in this country, but proper methods of utilisation are likely to promote considerable economy in the cost of fuel for the industries and what is of more interest to the country it would ensure a longer life to the limited reserves.

There can be three ways of effecting conservation of irreplaceable resources:—

1. Conservation in mining.
2. Conservation in treatment and proper processing and consumption *i.e.*, efficient utilization.
3. Replacing the exhausting natural fuels by substitutes which may be prepared from other resources.

It is well known that the methods of utilisation of coal as at present practised in India are inefficient

and coal is mostly consumed in the raw state without previous processing. In other countries, fuel economy is almost a national movement and all conceivable attempts are being made to reduce the consumption of fuels per unit of power or heat obtained. For example, in Great Britain the total consumption of coal in 1913 was about 185 million tons and in 1935 even with the increased industrial expansion its consumption was only about 162 million tons. How has it been possible to derive more power when the total consumption has been falling down? The answer is simple and obvious—better utilization of fuels.* It has been estimated that by adopting more efficient methods alone, Great Britain has been able to save twenty to twenty-five million tons of coal annually, *i.e.*, about 12 per cent. of the total consumption. There are two agencies which may be interested in fuel economy, *viz.*, the consumer having financial considerations and the Government as a guardian of the interests of the country. In most of the countries, the consumers have taken the initiative in fuel economy, chiefly due to the high cost of fuel. In Germany, it is not only the consumers who have been concerned with fuel economy, but the State has taken a very active part in ensuring that no waste is allowed to occur in

* For example, in 1913, nearly four pounds of coal were needed to produce one unit of power. By 1937, the power machinery had been so much improved that only one pound of coal was sufficient for producing one unit of power. The present day industrial activity of England is estimated to have increased about three times.

utilization and that all valuable products are recovered from coal.

In England the movement was started mainly by the efforts of the private enterprise added by the Fuel Research Board. The price of coal in England has been appreciably high and it is evident that the principal consumers should have made serious attempts to reduce the proportionate cost on their fuel consumption. In the United States of America even with the abundant resources of fuels at her disposal, voluntary efforts in fuel economy have been pursued with State aid, both technical and financial.

In India, the price of coal is very low and it is natural that the consumers have not been very much interested in fuel economy. Moreover most of the plants and appliances needed for better utilization have to be imported at a fairly high price and as such involve the investment of a good deal of capital. If after all this initial expenditure and increased supervision one can effect some economy, due to low price of coal the investment would be found to be an economically unsound proposition. It is only when the price of coal has suddenly increased or there are competitive considerations that voluntary attempts for fuel economy have been made by some of the principal consumers, notably the iron and steel industry. Other industries which are consuming an appreciably large amount of fuel by inefficient methods have remained more or less indifferent.

It is now generally recognised that the serious wastage of coal and its products caused in mining and utilization have been largely due to the uncontrolled production and distribution which together have brought about a keen competition in the trade. The Indian coal industry is notoriously one which may be called "a house divided against itself". This has given rise to unusually low prices of coal. The coal purchase policy of the Railway Board has been largely responsible for these low prices. The colliery owner cannot resort to efficient methods because of inadequate return. The consumer, on the other hand, due to the availability of very cheap fuel does not consider it worth while to think seriously of fuel economy. This system of distribution, therefore, has created a vicious circle, out of which the industry now finds it difficult to emerge and it has been one of the principal causes of the wasteful practices employed both in mining and utilization.

Several workers interested in the fuel problem, notably Pascoe, Fox, Sen, Coggin Brown, N. P.

Gandhi, Chatterjee, Forrester, etc., have from time to time emphasised the need for the establishment of a fuel research organisation. The Coal Mining Committee (1937) also made a suggestion to that effect. The National Institute of Sciences at one of their symposia in 1939 passed a resolution recommending to the Government for the early establishment of a Fuel Research Board. Most of the above named workers have suggested the organisation of fuel research mostly from the investigational point of view. But it is evident that the coal industry has come to its present unsatisfactory state not only due to the absence of fuel research, but primarily due to unorganised development and absence of control on production and distribution. Unless the industry is properly controlled in the spheres of production, distribution, utilization and even organisation, there is little chance of its being placed on a firm basis and consequently less possibility of avoiding wastes.

We, however, feel that an organisation entrusted mainly with the task of carrying out investigations on fuel problems without requisite power for effective control will not be very helpful in ensuring a proper utilization of fuels. In the absence of a properly constituted authority, the results of investigations sometimes obtained after a great deal of expenditure, will remain buried in departmental reports or only those methods would be utilised which may bring an immediate return on the capital. Instances are not wanting, when the introduction of efficient methods has occasionally meant a great deal of initial expenditure and the beneficial effects of such investments have been realised only after the lapse of some time. We may cite the case of the very great improvement in the methods of coke manufacture. The present method of its manufacture in the bye-product coke ovens has been developed after a long series of investigations and involves a considerable expenditure in the initial stages. The new method has been of benefit not only to the industry but also has proved to be of great significance to the country as a whole. It recovers valuable bye-products which serve as raw materials to several important industries and it is the function of the State to see that this method is generally adopted in the manufacture of coke. In India, with the exception of large concerns such as the Tata Iron and Steel Co., the Bararee Coke Co., etc., coke is still manufactured in the beehive coke ovens resulting in the loss of valuable constituents. There are several other wasteful practices prevalent in the utilization of fuels, for example, the misuse of

coking coal, the direct burning of coal in some of the manufacturing industries without previous processing etc. The misuse of coking coal is one of the most discussed subjects.

It is well known that India produces about 13 million tons of coking coal of which not more than 4 million tons are utilised by metallurgical industries. The rest is consumed by the railways and other industries. Some of the collieries which produce only coking coal are owned by the State railways and this much-needed coal is consumed by them mostly in locomotives. The State even on repeated warnings has not been able to stop these harmful practices. Much more surprising is the fact that some of the iron and steel companies have been found (as reported by the Coal Mining Committee of 1937) to sell their coking coal to the railways and at the same time have been crying hoarse to impress upon the Government to stop the misuse of coking coal. With such past experiences how can one believe that even if some blending tests come out successful, they will be utilised? The immediate solution of the problem of coking coals is the restriction and control on the output of coking coal. This can only be achieved through State intervention.

From the foregoing account it will be evident that the fuel problems are so varied and complicated in nature that they can only be solved by a central body pursuing a unified fuel policy, and controlling the fuel industries in all the spheres, i.e., organisation, production, distribution and utilization. In other countries where there are several bodies entrusted with fuel problems it is being increasingly recognised that a proper and effective control can only be ensured through a central agency. In this connection we quote below two passages from the speeches of the Presidents of the Institute of Fuel, Great Britain :—

"May I plead that in the interests of the coal industry and the nation, a really powerful organisation be formed to undertake research and to deal authoritatively with all matters relating to the preparation of coal for the markets and its known uses and those yet to be discerned? An organisation such as I visualise would raise the industry to a technical level hitherto not imagined." (Lord Hirst, 1931).

"We are at the beginning of an era which is to treat coal as a raw material for manufacturing processes, and it is a matter of the greatest national importance calling for the advice of the highest authorities in each section of the industry. Only by one central body can guidance be given

which shall place the nation on the road which will produce the greatest benefit for all sections of the community, and in order to co-ordinate the whole of the power and heating requirements of this country it is recommended that a new, permanent, Central Body be created by an Act of Parliament". (Sir Phillip Dawson, 1937).

Further

"It is therefore disturbing to all who are closely concerned with the fuel industry in this country to realise that the Government are lethargic on this matter or have not apparently appreciated the fundamental importance of setting up a machinery towards the establishment for the utilization of the nature's fuel resources, which are after all the fundamental assets the country possesses."*

In India there are organisations, some of which are wholly and some others partly concerned with fuel problems, such as the Geological Survey of India, the Indian School of Mines, Dhanbad, the office of the Chief Inspector of Mines, the Coal Grading Board, the Sand Stowing Board, the Indian Soft Coke Cess Committee etc. There is hardly any co-ordination in their activities and they do not appear to follow any definite and unified policy. It may not be too much to say that at least one of them, such as the Soft Coke Cess Committee has failed to justify the expenditure of a large sum of about a lac of rupees collected from the cess levied on soft coke, since the slight increase in the consumption of soft coke after its establishment is more due to the very low price of coal in recent years than due to the effect of its propaganda. Moreover, there may be some problems which though apparently uneconomic may require to be tackled in the wider interests of the nation. One such problem is that of the production of liquid fuels from coal and the recovery of by-products of coal carbonization. The urgency of this problem in India is obvious. The above bodies, scattered as they are, cannot investigate this important problem in an organised way. It is necessary that for a proper co-ordination of their activities they should be subject to the control of a central agency.

In the absence of a properly constituted central authority, it is indeed difficult or we may say almost impossible to effectively pursue a unified policy of fuel conservation on an all-India basis. The problem of fuels is an all-India one and should on no account be left to the provincial authorities, who will always be hampered in adopting a uniform policy.

* Boon. *Jour. Inst. Fuel*, 1940, p. 124.

DECLARATION OF A NATIONAL FUEL POLICY— THE FIRST STEP.

In a previous issue* we emphasised the need of a national fuel policy and if a programme of fuel conservation is to be given effect to, it is essential that the State should make a declaration on fuel policy *i.e.*, we must clearly know our aims and problems.

A clear declaration of National Fuel Policy is therefore a prerequisite to adopting any measure. The guiding principle in laying down a national fuel policy should be the interest of the nation as a whole considered from the view-point of the present and future welfare, which must be supreme and should not be allowed to be subordinate to vested interests. The central idea should be, that for every major use, such as for the consumption of fuel by railways, by the iron and steel industry etc., the nature of the fuel should be determined considering its future and present availability. Also, if a fuel is considered to be indispensable for the prosperity of a certain key industry whose decay may even endanger the safety of the nation, every step should be taken to ensure that it is used for the specific purpose. No fuel, howsoever, inferior and small in quantity should be allowed to be wasted and there should be no misuse of any fuel. Also if a source of power can be used which may dispense with the use of fuel thus indirectly helping its conservation, the State should investigate its possibilities. One such example is the use of hydroelectricity for running the railways. Efforts should be made for the discovery and production of substitutes for the fuels, such as power alcohol to replace petroleum, for which the country has to depend on imports and whose supplies during times of emergency may be cut off thus threatening the welfare and defence of the country. All legal difficulties which stand in the way of the National Fuel Policy should be removed. These are some of the broad principles upon which a fuel policy has to be based. As experience accumulates and new problems arise, it may be necessary to make changes whenever necessary in the national interests, which we repeat, should always be supreme.

On declaring the national fuel policy, the Government should appoint a machinery responsible to execute it. It may be interesting to note here that

the National Planning Committee in its ad interim report on Power and Fuel have strongly recommended the control of the coal industry by the State and the establishment of a National Fuel Board responsible for exercising this control, under a joint commission known as the National Power and Fuel Commission. Since the problems of fuel and power are so much interlinked, it is desirable that they should be under a joint control. Under the National Fuel Board there should be four committees:—

1. The Fuel Production Committee.
2. The Fuel Distribution Committee.
3. The Fuel Utilization Committee.
4. The Fuel Organisation Committee.

That the early establishment of such a control organisation is necessary and long overdue cannot be questioned specially in view of the so many misuses and wasteful practices both in the production and utilization of fuels. We may mention here that there are in India such organisations as the Central Cotton Committee, the Central Jute Committee, the Indian Lac Cess Committee, which look after the particular industries.

The coal industry is the principal fuel producing industry in India with a capital of about fifteen crores of rupees. Fuel industries occupy a key position in the welfare of other industries and are essential for transport and power. We are of opinion, therefore, that the Government should exercise a strict control on the fuel industries, through the National Fuel Board which should be the supreme controlling authority and should advise the Government from time to time with regard to the necessity of making new laws or amending the existing ones in the interests of the nation. Also, when a certain law has been enacted by the Government, it should be the duty of the Board to put it into effect, for which purpose it should be vested with the requisite power. Thus the Board should be both of an advisory and supervisory character. Further, like the Railway Board it should not be a body composed of Government officials only. Once such an organisation is established vested with the necessary powers, the solution of fuel problems of India will be comparatively easier. As already pointed out there are such organisations on power and fuel in several other countries, notably the United States of America, Germany, France, Russia, Great Britain, Canada etc.

* SCIENCE AND CULTURE, 6, 61-62, 1940-41.

It is well known that by exercising strict supervision, Germany,* has been able to develop a system of fuel economy and power industries which is still unsurpassed in the world. Under the Fuel Board there should be at least two Institutes—the Fuel Research Institute for investigating problems of fuel utilization, safety in coal mines, petroleum installations etc., and the Geophysical Institute for a proper development of the methods of prospecting and pro-

* Regarding Germany's control of power industries, we may mention that by exercising a strict control on the existing power companies, she has been able to raise her total energy production from fifty thousand million units to nearly hundred thousand million units though the addition to producing plants has been only about twelve per cent.

duction. The Board should be liberally financed by the Government and the former should co-ordinate and utilise the facilities existing in other institutions by allocating appropriate grants. The recent appointment of a Fuel Research Committee under the Board of Scientific and Industrial Research is a rather feeble attempt in this direction. The bad condition of the fuel industries in India and their importance in national life demand a more powerful organisation. We hope that in the interests of the nation, the Government even after their long and continued inactivity will take early steps to declare their fuel policy and establish a central organisation responsible for carrying out the policy.

JOINT EASTERN SESSION OF SCIENTIFIC ASSOCIATIONS AT BANGALORE

A joint session of the Association of Technologists, Bangalore, the Indian Academy of Sciences, the Indian Chemical Society (Bangalore branch), the Institute of Chemistry (Indian section), the Society of Biological Chemists (Bangalore branch), the South Indian Science Association and the Technical Association, Bhadravati, was held in Bangalore on the 10th and 11th April, under the presidency of Sir C. V. Raman, Kt., F.R.S., N.L.

The proceedings began on the 10th morning with an inaugural address by Sir C. V. Raman on 'New X-ray Effect on Crystals'. After a few preliminary remarks Sir C. V. Raman gave an account of the work which was being done in the Indian Institute of Science by himself and Dr Neelakantan on the subject. He referred to the nature of the oscillations—how they were excited and how they should calculate the results. The inaugural address was followed by a paper on 'Recent Advances in Cosmic Ray Physics' by Dr Homi J. Bhabha, F.R.S. Dr Bhabha gave a historical survey of the subject. He dealt with the phenomenon known as "Cosmic Ray Showers", the theory of Heisenberg and the Bhabha-Heitler Cascade Theory. He pointed out the various defects in the theory of Heisenberg and said that he was carrying out some experiments to test his own theory in the Indian Institute of Science. Prof. C. K. Sundarachar then read a paper on 'Recent

Advances in Nuclear Fission'. A few original papers concluded the morning session. The President, Sir C. V. Raman, was at home to the delegates in the evening. The day's proceedings concluded with an interesting public lecture by Mr M. Srinivasaya of the Indian Institute of Science on 'The Story of Vitamin D'. Mr Srinivasaya gave an account of the discovery of vitamin D and described its preparation, properties and uses. During the course of his lecture he referred to the work which is being done by himself and his colleagues at the Indian Institute of Science on the production of vitamin D from yeast.

On the 11th morning the proceedings started with an interesting paper on 'Recent Advances in Protein Chemistry' by Dr M. Damodaran, professor of chemistry, University of Madras. This was followed by a paper on 'Some Antigenic aspects of Bacterial activity' by Dr C. V. Natarajan, superintendent, Vaccine Institute, Bangalore. Mr M. Srinivasaya gave an account of 'Recent Advances in the Bio-Chemistry of Plant Viruses'. Some interesting original papers were also read.

In the evening Sir C. V. Raman gave a very interesting public lecture on 'Earthquakes'. The Session concluded with a subscription dinner.

C. V.

Animal Husbandry and Crop Planning in India

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INTRODUCTION

IN a country such as India, where agriculture is the mainstay of the economic structure, the important position of animal husbandry in guarding national prosperity is obvious. Indeed, practically the whole motive power for agricultural operations is derived from animal labour. Moreover Indian cattle are simultaneously called upon to play the customary role of maintaining national health by supplying milk and milk products. Unfortunately, even though it occupies such an important position in our national existence, the livestock of India has been sadly neglected. The efficiency of Indian cattle has systematically deteriorated owing to the defective agricultural policy of this country during the past few generations. On the one hand, driven by abject poverty, the Indian peasant has been utilizing every piece of available arable land for growing crops which will bring him immediate cash, such as cereals, millets and oil-seeds. On the other hand, the industrialist has tempted the cultivator to use the rest of the useful soil for growing plantation crops such as jute, tea, sugarcane and tobacco. No thought has ever been given to keeping in reserve a portion of arable soil for growing fodder crops and grasses—that is, natural food—for the feeding of livestock. Thus for decades, the cattle population of India have been eking out a miserable existence on such foodstuff as straws, *bhoosa* and cake,—the residues in the processing of cash crops. As the production of cash crops is limited by the capacity of the land and the actual demand of the human population, these residues are not available in any quantity.

INADEQUACY OF AVAILABLE FOODSTUFFS

It has been possible to estimate the amount of by-products and fodder crops available for animal feeding and it has been found that this amount is

far below requirement. This will be evident from the figures given in the following table:

TABLE I.
AVAILABLE SUPPLY IN INDIA

	Raw material	Dry matter
	(million tons)	
Straws	... 135'1	121'7
Green fodder	... 169'0	33'8
Concentrates	... 4'2	3'8
Bran, etc.	... 3'3	3'0
Total	... 311'6	162'3

According to available figures, the cattle population, including buffaloes of India is 215 millions. There are in addition 97 million sheep and goats and 1 million equines. Omitting from our calculations sheep, goats and equines and considering only the 215 millions of cattle, the available dry matter supply per head per day comes to about 4'4 lb. of which only 0'2 lb. is concentrate. If we assume that the average body weight of the Indian cow is 400 lbs., then the average dry matter requirement per head per day for maintenance is 8 lb. (inclusive of the concentrates). It is apparent, therefore, that for the maintenance of mere existence, the available food-supply is 45 per cent short of the actual requirement. It will readily be recognised that if the animal is producing milk or performing work, the requirement will be even higher and the shortage of foodstuffs consequently be more acute.

Fortunately, the above figures do not take into account the uncultivated fodder, such as pasture grass and forest grass or hay. The extent of supply of these indigenous grasses cannot be accurately assessed but it is nevertheless high and when properly mobilised and made available to stock owners, the

apparent shortage of food can be very considerably reduced.

Having reviewed the position as regards the quantity, the question naturally arises, "What is the quality of the available foodstuffs?" Before answering this question it may be advisable to make a brief survey of our knowledge regarding the quality of food in relation to stock-feeding.

QUALITY OF FOOD IN RELATION TO STOCK-FEEDING

Not very many years ago, nutritionists interested in stock-feeding usually laid stress only upon the quantitative sufficiency of such nutrients as energy and protein. The work of the past 30 years has, however, shown that milk yield, growth, health and reproduction are significantly influenced by substances which are not taken into account in calculating either energy or protein. The discovery of vitamins and the recognition that foods may be adequate as regards energy and protein but still be deficient in certain essential minerals, have shifted the balance of interest in nutrition from quantity to quality.

Authoritative opinion inclines to the view that the danger to farm animals consequent upon insufficiency of vitamins is less than to human beings. 'The farmer himself is much more likely to suffer from vitamin deficiency than the animals he feeds'. Perhaps this is true only when animals consume their natural food in the form of green grass or fodder. It has been shown by several workers during recent years that the continuous feeding of artificial foods, such as straws and cakes and the rigorous omission of green stuffs from the ration, bring about sooner or later the demand for specific vitamins. Moreover, as has been suggested by some workers, 'it is possible, indeed highly probable, that there may be undiscovered food factors in natural food like green grass, which are of importance in livestock feeding'. Experimental evidence appears to show that animals acquire natural immunity from infection if they are allowed to graze on green grass. This acquirement of natural immunity suggests the presence of a property in green grass which has an influence on the defensive mechanism of the animal body. The intensive work which is now being carried out in some American laboratories on the so-called "grass juice factor" is another evidence of this.

It is now well known that, though most of them are required only in relatively very small amounts,

the minerals play an important physiological function in the living organism and it has been firmly established that many problems of nutrition bearing on the economical use of feeding stuffs and also on the incidence of pathological conditions are intimately connected with the supply of inorganic constituents, particularly of calcium and phosphorus, in the ration. Elements such as sodium, potassium and chlorine, which are required in relatively larger amounts and other elements such as iodine, iron, copper, cobalt and manganese, though required in minute quantities, exert also a profound influence on the health and growth of the animal.

Apart from vitamins and minerals, there still remain for consideration other qualitative aspects. The most important of these perhaps is the quality of the protein of the ration. The term "protein", as it is commonly understood in stock feeding, includes both true protein and protein degradation products or non-protein nitrogenous compounds. The nutritive value of the latter is perhaps limited to maintenance alone and the protein value of a feed, at least for all productive purposes, should be reckoned by the amount of true protein present. Then again, a general name like "protein" is of limited significance, since no two proteins are alike. There are as many proteins as there are protein sources and every one of them has a different efficiency or biological value.

Finally, when considering the quality of a fodder one must not overlook such factors as its palatability, its digestibility and the amount and kind of fibre it contains.

QUALITY OF CATTLE FEED IN INDIA

If we attempt to appraise the quality of foodstuffs commonly fed to cattle in India in the light of the observations made above, we shall be presented with the following revealing features.

As straw constitutes by far the largest amount (about 80 per cent) of the total roughage supply, we shall consider it first. Normally in straw, digestible protein is nil, starch equivalent or available energy is about 20 per cent, lime content 0.20 to 0.42 per cent, phosphate 0.05 to 0.20 per cent, while carotene or vitamin A is practically absent. This fact at once brings out the appalling qualitative inadequacy of this staple food of Indian cattle. While Indian dry roughages do supply a certain amount of energy, yet their lack of digestible protein, their low lime

and phosphate content and their practically complete lack of any source of vitamin A lead to various obvious pathological conditions such as osteomalacia, aphosphorosis, ophthalmia and blindness in calves and abortion of non-specific origin. Moreover one can at any time see their effect in Indian cattle in a general unthriftiness, a stunted growth and a late maturity. Furthermore, when one views animal nutrition in relation to public health, one finds the position equally disquieting. As the supply of protein-rich cake is meagre and as no protein is available in dry roughage, the daily milk production of Indian cattle is found to be only 8 ozs. per head of population, a figure which suffers a poor comparison with the figure of over 40 ozs. in most European countries. In view of the special importance of milk in human diet (15 ozs. of milk has been suggested for consumption per head of population 'to make it a feasible standard under Indian condition')—the present supply appears to be too low even to maintain the minimum level of national health.

Proceeding to the case of concentrates available in India, we have various oil cakes, cotton seed and by-products of crop processings, such as bran and pollard. These concentrates are, it is true, protein-rich food and, when supplemented in the usual sole feed of dry roughage, they partially mitigate the complete absence of digestible protein in the ration. But one cannot ignore the fact that concentrates are a badly balanced food, being inherently deficient in calcium and vitamin A. Moreover, recent researches tend to show that protein in cakes is only of limited value. Thus some workers have shown that, whereas the biological value for milk production of protein in fresh spring grass is 80 per cent, the efficiency of protein in linseed cake is only 45 per cent.

If from the above resumé we are convinced that not only the quantity of the foodstuffs consumable by livestock in India is below requirement but also that the quality of available feed is open to serious question, the task before us becomes clearly defined.

INCREASED SUPPLY OF GOOD QUALITY CATTLE FEEDS

The solution of the problem of the proper feeding of livestock lies in supplying abundance of their natural foods—pasture grass and suitable fodder plants, which will guarantee both quantity and quality. In India, unfortunately, many an easy solution is set at naught by factors which cannot

be controlled by human agency without heavy expenditure. Thus a good pasture perhaps offers the immediate short-cut for successful stock feeding, but the climate and, in many places, the soil do not permit the maintenance of a pasturage of requisite quality for any length of time. This fact, however, should not discourage schemes for the improvement of whatever pasturage is available for crop production for livestock feeding. But the chief solution, perhaps, lies in growing more and more fodder crops of suitable quality. The criteria of suitability which will guide the process of selection amongst the many species of cultivated and non-cultivated fodder crops, which are known to grow in India, are simple to decide. Perhaps the primary index of suitability will be the nutritive ratio, *i.e.*, the ratio between the digestible crude protein and the combined digestible carbohydrates and fats. This nutritive ratio for the ordinary purpose of maintenance should not be wider than 1:10 to 1:12. For specific functions, such as growth and milk production, it is desirable that the nutritive ratio should be narrower, say, 1:4 to 1:6. The next consideration of importance is the mineral supply, particularly that of lime and phosphate. It is desirable that both the lime and phosphate content of the fodder should be within 0.7 to 0.8 per cent. on dry basis. As the forages are naturally rich in carotene, the question of adequate supply of the required vitamin needs no special consideration.

Judged from the data on composition and digestibility hitherto available, the following fodder crops can be cited as those which come under the first category, *i.e.*, with nutritive ratio 1:10 to 1:12 when fed either green or as hay:—

1. Young juar.
2. „ Maize.
3. „ Oats.
4. „ Bajra.
5. Elephant grass in prime condition.
6. Guinea „ „ „
7. Sudan „ „ „

In addition to the above cultivated fodders, we have recently been able to demonstrate that some of the indigenous grasses which grow wild—namely, Anjan (*Pennisetum cenchroides*) Dub (*Cynodon dactylon*) and Spear grass (*Andropogon contortus*) are good fodders and are suitable for reseeded and cultivation.

To the other category, that having the narrower nutritive ratio, belong the leguminous fodder crops such as Berseem, Lucerne, Cowpea and Senji. Legumes, both green and as hay are highly palatable. They are rich in protein of an excellent quality, are perhaps the richest source of available calcium among the fodder crops and are unquestionably rich in vitamin A. Some of the striking observations recently made by workers at the Bharari Cattle Farm, U. P. on the effect of feeding berseem to growing and milch stock may be summarised here:

(a) The rate of growth obtained even with maximum replacement of concentrates by berseem compares well with that which is to be expected under normal conditions. The cost of production per unit of growth is at a minimum in the case of heifers getting the maximum nutrients in the form of berseem.

(b) In the case of milch cattle, there was no difference in the average milk yield of the groups getting full concentrates and that of animals getting 50 per cent. of the concentrates replaced by berseem hay; the live weights were maintained equally effectively and there was practically no difference in the composition of the milk obtained. But the cost of producing milk was decidedly higher with the full concentrate ration than when berseem hay replaced 50 per cent. of the concentrate.

These observations show not only the nutritive superiority of legumes as cattle feed but also demonstrate that legume forage can economically replace costly concentrates. The comparative food values of those straws and green fodders discussed above are given in table 2, a perusal of which will clearly

show the inferiority of the staple feed of Indian cattle.

TABLE 2.

STRAWS VERSUS CULTIVATED GREEN FODDERS
(Per 100 lb. dry materials)

Feeding stuffs.	Digestible protein.	Total digestible nutrients.	Lime.	Phosphate.	Carotene or vitamin A potency.
	lb.	lb.	lb.	lb.	
Ragi straw	0.23	55.63	1.11	0.16	nil
Rice straw	0.00	50.23	0.40	0.25	nil
Wheat straw	0.00	48.95	0.42	0.05	nil
Green Bajra	4.31	59.24	1.06	0.42	Moderate
„ Maize	4.68	67.77	0.73	0.63	„
„ Juar	4.20	56.27	0.59	0.32	„
Guinea grass	5.83	65.09	0.71	0.56	Rich
Elephant grass	3.85	55.39	0.70	0.61	„
Berseem	12.56	59.68	2.69	0.64	Very rich

RECASTING OF THE PRESENT AGRICULTURAL POLICY

In the foregoing brief account, we have attempted to present the problem of the quantitative as well as the qualitative insufficiency of foodstuffs for stock-feeding in India. We have indicated also that this dual insufficiency can be made good only by providing more fodder crops of suitable quality. If the animal wealth of India is to be restored, the immediate necessity is a rational recasting of the agricultural policy of the country. The present system of extensive cash crop production is not only affecting the soil but is also seriously restricting the adequate production of fodder crops for cattle feeding. This will be apparent from table 3.

TABLE 3.

THE SUPPLY OF DRY MATTER FROM STRAWS AND FODDER CROPS, AND THE RELATIVE ACREAGE DEVOTED TO THEIR CULTIVATION IN THE MAJOR PROVINCES OF INDIA

Province.	Dry matter from straw etc. residue from cash crops. (mill. tons)	Acreage under cash crops. (mill. acres)	Dry matter from cultivated fodder crops. (mill. tons)	Acreage under cultivated fodder crops. (mill. acres)	Total dry matter production. (mill. tons)	Total acreage under cultivation. (mill. acres)	Cattle population. (mill.)	Total dry matter available per head per day. (lb.)	Percentage of total cultivated land devoted to fodder crop production.
Bengal	10.2	22.6	0.3	0.2	10.5	22.8	25.3	2.5	1
Bihar & Orissa	9.2	23.6	3.0	1.8	12.2	25.4	21.3	3.5	7
United Provinces	15.6	35.0	6.2	3.6	21.8	38.6	32.5	3.9	9
Madras	15.2	25.4	0.7	0.5	15.9	25.9	24.6	4.0	2
C. P. & Berar	7.0	19.7	0.9	0.6	7.9	20.3	13.8	3.5	3
Bombay	8.6	19.6	4.9	2.8	13.5	22.4	10.0	8.0	13
Punjab	9.0	20.8	10.8	6.2	19.8	28.0	15.8	8.0	22

From the above table, it will be seen that the percentage of total arable acreage devoted to fodder crop cultivation in provinces like Bengal, Madras, and C. P. and Berar is very small, varying from 1 to 3, in Bihar and Orissa 7, in the U. P. 9, in Bombay 13 and in the Punjab 22, while the percentage for the whole of India is barely 5. The scarcity of fodder crops in certain provinces of India is more glaringly evident when we attempt to show the density of cattle population per unit acreage of cultivated fodder crop. This is set out in table 4

TABLE 4.

NUMBER OF CATTLE PER ACRE OF CULTIVATED FODDER CROP IN THE MAJOR PROVINCES OF INDIA

Province.	No. of cattle per acre.
Punjab	2
Bombay	3
U. P.	9
Bihar & Orissa	12
C. P. & Berar	23
Madras	49
Bengal	126

The primary demand in the new agricultural policy which we envisage will therefore be firstly, to open up fresh arable acreage for cultivating suitable non-leguminous and leguminous fodder crops; and secondly to restrict cash crop cultivation and to reserve a significant area for growing leguminous forages. In a long range policy, this reservation of acreage is bound to justify itself on many grounds. A larger production of legume fodder will not only increase the ideal food for livestock but, because of their peculiar virtue, legumes will also enhance the fertility of the soil. The increased soil fertility will thus be achieved in yet another indirect way. The extra forages consumed by cattle will return to the soil in the form of manure provided we adopt a system of mixed farming. With the return of ferti-

lity, there will no longer be any necessity for the extensive system of cultivation; the farmer should get all the cash crops he requires within a smaller acreage under an intensive system of production. Finally, will not a fertile soil confer a better quality on dry roughages such as straw and *bhoosa* which can never be entirely ousted from the dietary of livestock?

While the overhauling of the existing agricultural practice is of urgent necessity, the task of achieving this will be in no way an easy one; in fact in some provinces it will be of extreme difficulty. In support of this view reference may be made to column 9 of table 3, which shows the total dry matter available per head of cattle per day. If we accept as suggested earlier, 8 lb. as the standard of dry matter requirement for an animal of 400 lb. live weight, the position regarding available food-supplies in most of the major provinces with the exception of the Punjab and Bombay is indeed serious. In view of the fact that there is at present no economical method of conserving pasture grasses which grow in considerable abundance during the monsoon period, the cattle population largely depends for its food-supply on cultivated dry roughages and in a smaller degree on fodder crops. Even if we assume that pasture grasses contribute at least 25 per cent. of the dry matter requirement, the available supply is not very significantly improved, as can be seen from table 5.

A study of table 5 shows that in most of the deficient provinces, an additional acreage, about 20 per cent of the existing total, is required to grow the necessary extra quantity of fodder crops. In Bengal, the additional requirement is 43 per cent., a figure which is indeed very high considering the density of the human population.

TABLE 5.

SHORTAGE OF FOOD-SUPPLY AND THE INCREASED ACREAGE REQUIRED FOR MEETING THE NECESSARY DEMAND IN THE MAJOR PROVINCES OF INDIA

Province.	The dry matter available from straw & fodder crops. lb.	The dry matter from pasture grasses. lb.	Total dry matter available. lb.	Shortage of dry matter. lb.	Total cattle population. (millions)	Total quantity of extra fodder required. (mill. tons)	Acreage required to grow the extra fodder crops. (millions)	Percentage increase in acreage to grow extra fodder crops.
Bengal	2.5	2	4.5	3.5	25.3	14.7	9.8	43
Bihar & Orissa	3.5	2	5.5	2.5	21.3	8.7	5.2	20
U. P.	3.9	2	5.9	2.1	32.5	11.7	6.8	18
Madras	4.0	2	6.0	2.0	24.6	8.0	5.7	22
C. P. & Berar	3.5	2	5.5	2.5	13.8	5.7	3.8	19

SUMMARY AND CONCLUSION

The ultimate object of crop planning is the improvement of national health and prosperity. In a country such as India, successful crop planning is intimately associated with a healthy livestock industry.

In order to ensure the optimum conditions in our livestock industry, we must be able to provide sufficient food of requisite quality for our animals. This is not available at the present moment. It has been found that we can supply only 55 per cent. of the requirement from our organised crop production and that the supply is very poor in nutritive value. Owing to this insufficiency both of quantity and quality, a number of problems have arisen which may be summarised as follows:

1. The productive efficiency of Indian cattle is systematically deteriorating owing to the prevalence of various types of under- and malnutrition.

2. For the restoration of productive ability, it is imperative to provide more food in the form of good quality fodder crops.

3. The increase in the fodder crop production can be achieved only partly by improvement in the methods of agriculture which may effect increase in the yield per acre.

4. The major quantity of necessary fodder production, however, can be achieved only by devoting more land for fodder crop cultivation. This increased acreage has to come (a) at the expense of some of the crops that are now being grown either for human consumption or for non-food cash crops

for industrial purposes and (b) by bringing extra land under cultivation.

5. The feeding problem must be solved on a regional basis.

If the extra acreage is not available for fodder production, as is likely to be the case in the thickly populated regions of the U. P., Bihar and Bengal, we have to consider how far the land which is already under cultivation for human food and non-food cash crops can be reappropriated. It must be understood that in this country, animals and human beings are constantly competing for the available land and with the tendency towards an increasing population, this competition will grow even keener. It is true that we have a large number of uneconomic cattle. The disposal of surplus cattle in India is a problem which, while demanding urgent attention, is beset with many difficulties. But sooner or later, we shall have to face the problem and a balance has to be struck somewhere to enable us to obtain a population figure commensurable with the food-supply.

It is probable that ignorance on the part of the cultivator has led to the large increase in this uneconomic cattle population, which cannot be kept in health and productivity with the existing food-supply. The situation has been aggravated by the lack of a suitable agricultural policy. So far as the farmer is concerned, his ignorance is perhaps excusable but it is the duty of those, who are responsible for India's agricultural policy, to see that the crop planning of the country not only serves the needs of the human population but also that of the enormous livestock population on which the continued prosperity of the agriculturist so largely depends.

Mitogenetic Rays

A MARIINSKY

IT is eighteen years now since the Soviet scientist A. G. Gurvich, at that time professor in the Crimean University in Simferopol, began experiments on the common or garden onion to test the scientific hypothesis of cell-division. This experiment, simple enough in itself, led to a discovery that constituted an entirely new chapter in the science of life.

Professor Gurvich devoted many years to the study of the life of the cells, which differentiating and multiplying, form a living organism. They multiply by division, we know, but how does this division take place? After a long study of this problem and thorough analysis of the known facts, Professor Gurvich arrived at the conclusion that division depends not only upon the complex chemical and other processes that continuously go on in the cell itself. A moment comes when, filled as it were to overflowing with life-force, the cell is ready to multiply. Yet, before this reproduction process can take place, some extraneous influence is required; then, and then only, can the cell begin to divide. This external factor that supplies the "urge" to split up, Professor Gurvich has called the "realization-factor". It must have a vibratory action, in other words, it is a question of the influence of radiant energy on the mitotic cell.

This was the hypothesis worked out by Professor Gurvich; it required to be tested by experiment. The presence of radiant energy had to be proved. In making his experiments he took as his starting-point the following premises: if the hypothesis of the existence of radiant energy is correct, then the plant in which intensive division of cells takes place ought to receive a considerable supply of energy from outside. But if this is the case, should not the surplus be released by the plant? Further, if this flow of space energy were to be directed to another plant with the power of cell-division, ought not the multiplication of the cells to be more intensive in parts under the action of the rays than in other parts where

the rays do not reach? If this experiment was successful, then the presence of radiant energy would have been established without a doubt.

EXPERIMENTAL VERIFICATION

In search of a suitable subject for experiment, Professor Gurvich decided upon the ordinary onion, a plant in the roots of which intensive cell-division goes on. His idea was that the surplus of radiant energy, received by the cells of the root, ought to escape through the end of it. The cylindrical form of the root and conical shape of its extremity ought to promote a certain concentration of radiant energy. This point was not on any account to be neglected, since the intensity of the biological radiation of the root would naturally be very feeble.

Now it was necessary to find an object—a "detector"—upon which the radiant source could act. For this purpose Professor Gurvich selected the same onion, because the cells in the root of the onion are arranged very symmetrically; if the root were to be divided lengthwise, then, each of the halves would invariably be found to contain an equal number of cells. Therefore, if the radiation evoked a more intensive process of division in the side of the detector nearest to the source of energy, this would be comparatively easy to observe. It only remained to count and compare the number of cells in the irradiated and unirradiated halves.

The root to be used as a detector was placed in an upright position in a stand, and the end of the root of another onion—the source of irradiation—was placed about half a centimetre away in a horizontal position. A few hours later the detector was subjected to examination. It afforded incontrovertible proof of Professor Gurvich's hypothesis. The irradiated part of the root was found to contain one-and-a-half times as many cells as the section from the part that had not received radiant energy. This experiment was subsequently repeated a great number

of times and yielded precisely the same positive results.

Now came the next step, which was to find out the nature of the radiant energy. A thin glass partition was set up between the detector-root and the source-root. The action of radiant energy on the detector was no longer to be observed; it had ceased entirely. As soon as the glass partition was replaced by one of quartz, intensive cell-division began in the detector. When the quartz partition was covered with a thin film of gelatine, cell-division was once more interrupted. The rays obviously could not penetrate glass or gelatine, but easily penetrated quartz.

Professor Gurvich called these *mitogenetic* rays (rays promoting cell-division). The problem that interested him was whether the mitogenetic rays discovered in the onion-root were ultra-violet rays. In that case the same effect of cell-division should be produced in the detector not only by the biological source (the root), but also by a physical source of ultra-violet irradiation. Ultra-violet rays coming out from the flame of an arc were made to pass through an ordinary quartz spectrograph; and the root of the onion was subjected to the action of different parts of the spectrum. Cell-multiplication was found to take place only under the influence of ultra-violet rays of a definite wavelength.

As the experiments on the mitogenetic rays developed, the results became more and more fascinating. It appeared that they were not produced by the onion-root alone; the same power of irradiation was discovered in the most widely-differing objects of the vegetable and animal world. Both the root and the base of the onion, the root of string-beans, the first leaves of the sunflower, the vascular-fibroid clusters of potatoes—all have the power of radiation. It is also common to some rudimentary organisms like infusoria, bacteria, and yeast and mildew fungi. At certain stages of development frog-embryos, parts of sea-animals, etc., have the same power. The tissues, blood, marrow of the bones, nerves and spleen, the cornea of the eyes, and the sperm of animals, give off these rays, which have been found to promote rapid growth in the seed of certain plants. Under their influence the larvæ of mosquitoes mature much sooner and some sea animals produce embryos of non-viable deformities, of which the cavities are over-brimming with cells of a definite kind. Further, it was found that mitogenetic irradiation renders

certain animal tissues and organs permeable. Where the liver of a mouse is placed in a special nutritive solution and subjected to radiation, certain substances such as phosphorus, sugar, etc., are given off by the liver, as will be seen by examination of the solution. On the other hand, a liver placed in the same solution, without being subjected to radiation, does not produce these substances or at the best, produces them in very small quantities. It appears, then, that mitogenetic rays have rendered the tissues of the liver permeable, and forced the organ to open, so to speak, and release part of the substances it contains.

Professor Gurvich has established the fact that in organisms irradiation is a characteristic of the metabolic process. The chemical changes that take place during metabolism is accompanied by the release of a certain amount of energy, including ultra-violet rays. Irradiation is a characteristic of the various chemical processes taking place during metabolism. The most fundamental of these are the processes of oxidation, disintegration of the albumins and carbons.

Since irradiation is characteristic of the organic chemical reactions accompanying the release of energy, the question arises whether it is possible to find it in similar non-organic reactions? A simple experiment was devised. Definite inorganic chemical reactions were produced in a vessel with a quartz side close to which a yeast detector instead of the onion used in the beginning was placed. It appeared that reactions of an inorganic nature did actually produce mitogenetic radiation. It was also discovered during electrolysis of water, where there was interaction of acids and lyes, where metals were dissolved in acid, where common salt was dissolved in water, etc. Thus, mitogenetic irradiation is a phenomenon to be observed not only in the organic, but in the inorganic world as well.

BIOLOGICAL UTILITY

A dog was given food containing an abundance of albumins. Then the food was extracted from the stomach and placed without delay in a quartz vessel that stood at the opening of the spectrograph. The digestive process and, consequently, irradiation, was still going on in the food. Yeast detectors were placed before the screen on which the spectrum of mitogenetic radiation was allowed to fall. It was found that not all detectors, but only some, react to

albumin radiation. Then the source of radiation was changed; the muscles of a frog stimulated by an electric current, were put before the spectrograph. Stimulation brought the muscles into action and the process of disintegration of the carbons gave out radiation. The latter, when it passed through the spectrograph, produced a response in a definite group of detectors. Thus it appears that the lines in the spectrum alter according to the nature of the chemical reaction producing radiation. The radiation produced by albumin-disintegration has its own set of lines in the spectrum, the radiation of carbon-disintegration another set and so on. If any mitogenetic radiation is subjected to spectral analysis, the nature of the chemical reaction evoking this radiation can be established, and, consequently, the chemical reaction taking place in the irradiated organic object.

This discovery is of the greatest importance, for it opens up new possibilities for research in processes taking place in the living organism. Up to the present, science had to be content with studying the consequences, rather than the actual course of processes in the living organism. For example, the blood of an animal had first to be extracted from the blood-vessel before it could be examined. It often happened that only the dross, the dead and not the living organisms, the results and not the movement and interaction of substances in the organism, were all that could be obtained for study. Now, however, it will be possible to make thorough and close observation of the life-processes as they take place and develop. The blood that circulates through the system of blood-vessels, irradiates through the walls of the vessels. Spectral analysis of this radiation will suffice to enable one to form an idea of the chemical transformations taking place in the blood. Since the chemistry of the blood is extremely sensitive to the slightest disturbance of the normal activity of the organism, this new method of examining it by mitogenetic spectral analysis can yield very rich and exact data.

Further study of the nature of mitogenetic radiation has shown that it is not always equal, but depends upon the nature of the external stimulation of the nerve. A blow on any part of the body evokes in the nerve a certain kind of chemical reaction (and, consequently, irradiation), an electric shock another kind of reaction, and so on. The chemical reaction of the visual nerve of a frog alters according to the colour of the source from which the eye is irradiated. In normal conditions, the cornea of a rabbit's eye

produces a species of radiation typical in the case of disintegration of carbons. But as soon as the rabbit suffers from hunger, and the animal's body begins to show a slight decrease in weight, the nature of radiation of the cornea alters its character; it now becomes irradiation of albumin-disintegration. The organism begins to live on its own resources and the outward sign of this is the irradiation of the cornea through the spectrograph.

Therapeutic Use

The above gives a general idea and a few of the results of Professor Gurvich's researches. It may be asked if this discovery has any practical importance, beyond its interest as a purely scientific problem.

It is difficult at present to give an adequate reply, but the experiments made by Soviet scientists have shown that mitogenetic radiation and its spectral analysis may become a new weapon in the fight against fatal diseases like cancer. The cause of this disease has not yet been established with certainty, but it is known that the cells of an organ affected by cancer cease to perform their useful functions. They multiply with great rapidity, corrupt the healthy tissues around them, absorb all the juices of the organism, exhaust it and ultimately destroy it.

The principal method of treatment is surgical operation. The success of this depends to a great extent on early diagnosis. Cancer is very difficult to detect. Little by little, almost imperceptively, it gains a hold on the organism, and it frequently happens that the doctor is only able to diagnose it after the most favourable time for its treatment has passed. So the tumour has time to poison the organism, set up new centres of disease in it; then treatment, if not entirely hopeless, is attended by great risk. Thus it will be clear that as early diagnosis is of the utmost importance in cancer, mitogenetic radiation ought to be of great use.

It has been discovered that a cancerous tumour is an extraordinarily powerful source of radiation, from five to ten times stronger than blood. It is evident from experiments that the irradiating organs of the human body, if subjected to prolonged "opposing" action from a powerful source, are temporarily deprived of their irradiative properties. This is not the case with a cancerous tumour; its irradiative power can be neither controlled nor modified. At the same time, another important pheno-

menon is to be observed: the blood of the organism attacked by cancer *ceases to irradiate*. This is explained by the fact that the tumour releases into the blood a substance that quells or "extinguishes" its radiation. Professor Gurvich has called this an "extinguisher", and some of its properties have already been determined. For instance, it has the power to multiply or enrich itself in the blood. It can be extracted from the blood in a solution of lye and in this form it continues to extinguish the irradiation of the blood, and is active even where a very weak concentration of it—one part to a thousand parts of the irradiated object—is present.

The discovery of this extinguisher permitted Professor Gurvich to test once more the influence of mitogenetic radiation on cell-reproduction. As soon the extinguisher was introduced into a yeast-culture, it ceased not only to irradiate but also to reproduce. But, scarcely had this culture been subjected once more to the action of radiation than its own powers of irradiation and reproduction were restored.

The knowledge that the blood of a cancerous patient ceases to irradiate promises medical science a means of detecting cancer in its early stages. Cases have been known when a sample of blood subjected to irradiation established the fact that a patient was suffering from cancer, though doctors who had employed other methods of diagnosis had found no symptoms whatsoever. Nevertheless, this new method has its drawbacks. For it is not only in cases of cancer that blood ceases to irradiate; the same thing may occur in the case of fatigue, or in old age, and in certain mental disorders. Doubts, therefore, may always arise regarding the true causes of this phenomenon. The extinguisher yields much more convincing proofs. Since it is found *only* in the blood of patients suffering from cancer, there is only one explanation of its presence. The blood of a patient suspected to be suffering from cancer is placed near a reliable source of irradiation. If the source is "extinguished", then the extinguisher must have been present in the blood and, consequently, the patient whose blood is subjected to this test is undoubtedly suffering from cancer. This

method has been applied in several of the clinics of the U.S.S.R. with extremely promising results. It is, of course, still being tested, and if in future it yields results as successful as those obtained so far, medicine will have gained a new means of recognizing cancer in its early stages.

It should be pointed out here that as soon as the cancerous tumour has been completely eradicated from the organism, irradiation of the blood begins once more. This renders it possible to determine with certainty whether the organism has been entirely cleared of cancer by the operation, or whether some hitherto undiscovered seat of disease still remains. To realize the full importance of this discovery it will be sufficient to remember how dangerous a relapse can be in the case of cancer.

Mitogenetic radiation promises new methods of treatment for certain mental disorders as well. A Leningrad psychiatrist, Dr Brainess has discovered that the blood of patients suffering from some severe mania possesses great power of irradiation, while the blood of schizophrenics has very little. After observing a number of cases Dr Brainess arrived at the conclusion that the transfusion of a very small quantity of blood from a mania-patient to a schizophrenic has a beneficial effect on the latter. Experiments proved the correctness of his theory. As is well known, schizophrenic patients are habitually depressed and low-spirited. Now, after they have been given a blood-transfusion—the blood of a mania-patient being employed—their appetite, formerly very poor, improves at once, and they begin to take more interest in what is going on around them.

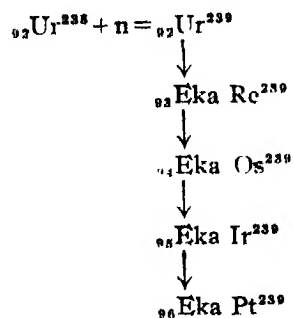
The discovery of mitogenetic radiation has aroused great interest not only among biologists, but also in kindred branches of science. Both in Professor Gurvich's central laboratory in Leningrad and in other scientific institutes in the U.S.S.R. further study of this problem and its practical application is being carried on. There is reason to hope that it will enrich science with new and more effective weapons to fight for the health and longevity of man.

Uranium Fission

M. N. SAHA

Palit Professor of Physics, Calcutta University.

THE total number of elements in this universe is known to be ninety-two. It has been an old question, why no elements beyond ninety-two have been found in Nature? Has the number ninety-two any magical significance as was ascribed to the number seven by the mystery-loving ancients, without any reason whatsoever? Fermi, an Italian physicist reflected about these questions and thought of outwitting Nature by smuggling a neutron into the nucleus of Uranium, thus forming a nucleus of weight 239 and looking for the consequences. It was a perfectly feasible procedure as the neutron, having no charge, has no shyness for the nucleus. Fermi found that several new products were formed all emitting β -rays; these were separated by chemical methods, and were found to possess properties which could, with certain amount of plausibility, be ascribed to elements 93 (ekarhenium), 94, 95, 96 (ekaplutonium). It was argued that nucleus of



weight 239 was short-lived, emitted β -ray and became element ninety-three, which in turn emitted another β -ray, and became 94, which is likewise unstable and the chain was continued till ninety-six (ekaplutonium) was reached.

But the very success of the experiments excited a certain amount of distrust. Other workers notably Hahn of Berlin, a celebrated worker in radioactivity stepped in and found that the number of new products was much larger, in fact Hahn identified nine distinct β -ray emitting products. One of these products was investigated by Curie and Savitch for its chemical properties, and though it was found to resemble to some extent the hypothetical element 89 in its properties, the similarity was found to be more

pronounced with lighter element lanthanum, No. 57. Following this work Hahn and his co-workers showed that some of products appeared to have the chemical properties of radium (88). But how could radium be produced at all in this class of reaction? Radium is element No. 88, and it could be produced only if the nucleus 92, or any hypothetical higher element produced on neutron bombardment, emitted alpha-particles and proton simultaneously or successively. This was not considered probable, at least no alpha-particle or proton could be detected, even after prolonged work. So Hahn and Stressemann began to doubt whether the radium-like products were at all radium; might not they be lower homologue of radium, *e.g.*, the common element barium, No. 56 which is very similar to radium in all its properties? The thought was given a trial and after a series of experiments requiring chemists' skill of the highest order, it was found that some of the products obtained by bombarding uranium with neutrons were undoubtedly barium nuclei.

This was a startling revelation. The element uranium is Number 92, while barium which is formed from it is Number 56. How can we get barium out of uranium at all? The explanation was almost forced upon the investigators that as a result of the impact of the neutron, the nucleus breaks up into two halves, one having the atomic number 56 and therefore the other probably having the atomic number 36 or 37. It may be emphasized, as will be elucidated presently, that the neutron which starts the process, need not necessarily be a 'high energy' one. Even small energy neutrons are capable of starting the reaction, which is therefore to some extent conditioned by something inherent in the properties of the uranium nucleus itself, or as was subsequently shown, of some of the other heaviest nuclei (*e.g.*, thorium and protactinium). Nuclei lighter than these have not yet shown the effect. We, therefore, conclude that the heaviest nuclei, particularly the uranium nucleus, possess to some extent

* Based on a lecture delivered by the author on March 26, 1941, before the Indian Physical Society.

latent instability in their structure, can divide itself on the slightest provocation, like some biological cells, into two distinct nuclei; the A-product having an atomic number varying from 50 to 60, the other, the B-product having an atomic number which varies from 35 to 42.

In the nucleus, the struggle is between the forces which keep the nuclear particles together, and the electrical forces of repulsion. The nucleus is *naturally* in a state of agitation owing to the large forces of repulsion and as a neutron approaches it exerts a kind of trigger action which make the two

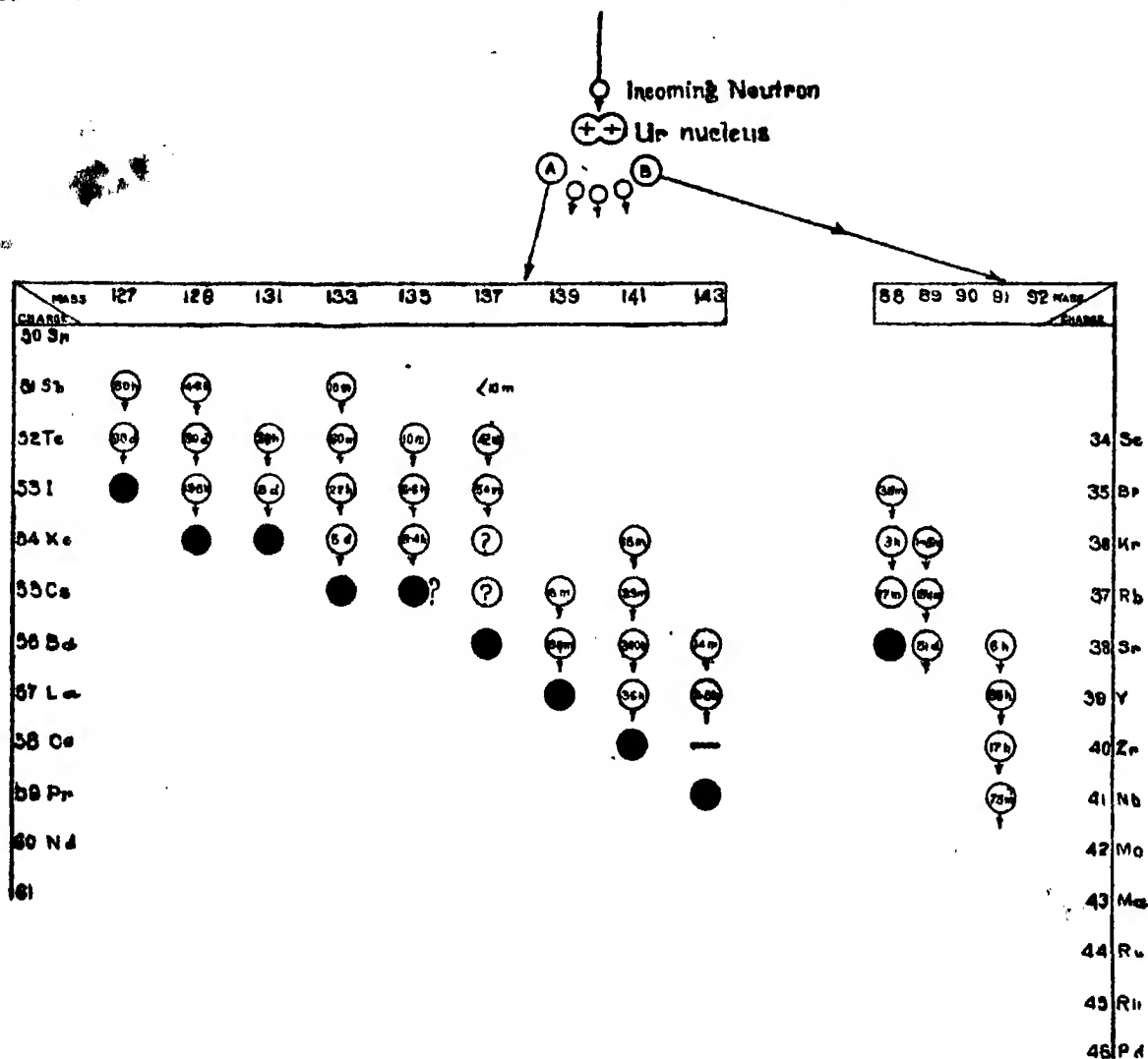


Fig. 1.

A diagrammatic sketch of the process of uranium fission is shown in figure 1. The uranium nucleus is shown, not as a spherical body, but as a dumbbell-shaped one. The total charge '92' is distributed amongst the two spheres constituting the dumbbell. In fact, Bohr compares the nucleus to a drop of liquid which, when highly charged, gets deformed, is set into violent vibration, and ultimately breaks up into two fragments. In a liquid drop, the struggle is between the surface forces of attraction and the repulsive forces due to the electrical charge.

parts fly asunder. As predicted by Bohr, it is the rare isotope U^{235} occurring in common uranium of atomic weight 238 in the proportion of 1:137, to which most of the fission activity is to be ascribed. It has been also found that at the time of rupture, a few neutrons (variously estimated at 2 to 3 per fission) are also emitted.

FISSION FRAGMENTS AND CHAIN OF β -RAY PRODUCTS

The two initial fractions A and B have charges varying from 50 to 56, and 42 to 36 respectively.

The total mass 235 is lessened by the number of neutrons emitted; hence the mass of the remainder, say, 230 is distributed between the two fragments. We have as yet no precise knowledge of the exact masses and charges of the fission-products at the moment when the fission takes place but let us denote them by M_1 and Z_1 , M_2 and Z_2 . From examination of fission products, it has been found that M_1 may vary from 127 to 143, and M_2 from 88 to 100 (this limit is indefinite). But a nucleus of this type is unknown in Nature. It has too small a charge for the given mass to be stable. For example, as far as we can see at the present times, one of the direct A-products, has a charge of 51, and mass of 133. Now in Nature, we have the following isotopes of Number 51, antimony.

$_{51}\text{Sb}$	121	123
	56	44

(The numbers on the upper line denote the weight, and those on the lower line the percentage of occurrence of the corresponding mass in a sample of the atom).

The A-product, $_{51}\text{Sb}^{133}$ is too heavy to be stable, it emits an electron (β -particle) and becomes $_{52}\text{Te}^{133}$; this also does not occur amongst the known stable isotopes of Te, which are

$_{52}\text{Te}$	120	122	123	124	125	126	128	130
	1	2.9	1.6	4.5	6	19	54	33

The $_{52}\text{Te}^{133}$, therefore, emits a β -ray, and becomes I^{133} and the chain of β -emitting products goes on till we land at the stable isotope $_{55}\text{Cs}^{133}$. Altogether four successive β -emissions have taken place in this chain. The instability due to the excess of mass in the fragments is compensated by increase in charge due to successive emission of β -rays.

So far, as many as nine sets of A-products having masses from 127 to 143 have been discovered, as shown in Fig. 1, and the successive chain of decay products have been traced satisfactorily. Curiously enough, they all appear to have odd mass numbers. Probably there are also even-mass numbered products amongst the A-fragments, but these appear to be stable and therefore appear so far to have escaped detection. The B-products have not been so far much investigated; the chains which have been definitely traced are shown in Fig. 1, but Japanese

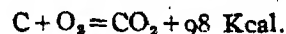
and American workers have reported Pd, Ag, and others to be present among B-products.

ENERGETICS OF URANIUM FISSION

The energetics of uranium fission have proved to be quite as interesting as the process itself, and opens up an alluring field of speculation on energy production.

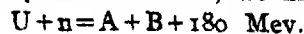
It was surmised from some theoretical considerations that the fission products should separate from each other with energies amounting to as much as 180 million electron volts on the average. The conclusion follows from certain empirical formulae enunciated by Bethe and Weisäcker which lays down the conditions of the stability of nuclei having the mass number M and the charge number Z . According to this speculation, the uranium nucleus is found to be somewhat heavier than the products of fission taken together. The excess mass should therefore, according to Einstein's principle of equivalence of mass and energy, appear as the kinetic energy of separation of the fission products. The paths of the fission fragments have been photographed in a specially designed Wilson Chamber and from the range and ionisation, it is possible to calculate the energy of each fragment. It is found that on the average, the energy with which the particles fly apart amounts to 180 Mev. thus confirming the theoretical prediction. This is an abnormally high figure and the discovery opens up a new vision of energy-production, which is extremely exciting.

Let us therefore compare the possibilities of this process with the usual thermal methods used in industry. All these methods employ in one form or other the burning or to use scientific language, the combustion of coal. The energetics are:



i.e., 12 gms. of coal, on complete combustion gives us 98 Kcal, i.e., the heat energy available is 8 Kcal per gm. of coal consumed.

In the present reaction, we have



When we convert the relation to energy production per gm. of uranium fissioned we obtain:

$$\begin{aligned} 238 \text{ gms of Ur gives us} \\ \frac{180 \times 10^6 \times 4.8 \times 10^{-10} \times 6 \times 10^{23}}{300 \times 4.2 \times 10^7} \\ = 4.1 \times 10^8 \text{ Kcal.} \end{aligned}$$

This gives us an energy production of nearly 1.7×10^7 Kcal per gm. of uranium consumed, i.e., by fissioning completely one gm. of uranium, we obtain as much energy as is obtained by burning about 2 tons of coal (2×10^6 gms.)

At the present time, every civilized country has to husband her power-resources and organise production and supply of energy for the whole country. According to modern standards, a civilized man should have at his disposal 1800 units of energy per year; barely 4 per cent. of the amount is available from human labour. The rest must be produced from coal, water power, or petrol. Thus England produced and consumed in 1939 nearly 25,000 million units of electrical energy and this was obtained by burning 40 million tons of coal (efficiency of conversion of heat to mechanical work is taken to be 30 per cent.). In addition to this, 60 to 80 million tons of coal were directly used in steam engines of all descriptions for producing energy. Let us ponder over the huge organisation and construction work required for generation and distribution of this huge amount of energy. First of all, nearly 100 million tons of coal have to be mined each year in Great Britain for power generation this requires a capital investment of hundreds of millions of sterling, and employment of millions of labourers for working the mines. The coal has to be burned in 60 superstations located in different parts of the United Kingdom, and distributed by thousands of miles of wire to substations in the principal cities; from these substations, they are distributed by licensed undertakers to the individual consumers in the city. The total capital involved in electrical undertakings is nearly 400 to 500 million pounds, and number of men employed in various capacities amount to nearly a million.

Now let us find out the amount of uranium whose fission will give us an equal amount of electrical energy. If we take a cube of uranium oxide (4.2 tons) the form in which uranium usually occurs, each side being one metre, then provided the whole amount of uranium contained in it can be made to undergo fission, the amount of heat produced will amount to nearly 5.8×10^{13} Kcal. If we succeed in converting 40 per cent. of this heat to useful work, we shall get nearly 25,000 million units of electrical energy i.e., a cube of U_3O_8 one meter on each side (weight 4.2 tons) will give us as much energy as 40 million tons of coal.

The calculation raises a lot of speculations but the main question is whether the scheme can ever

be a practical one. The first difficulty is the assumed cent.-per-cent. fission of uranium. Under the present experimental conditions, the efficiency of fission is extremely slight. It is estimated that hardly one in 10^{24} neutrons hurled at uranium succeed in causing fission in U^{238} , and probably one in 10^{21} neutrons in U^{235} . Most of the neutrons, therefore, pass out innocently and are lost to us, without causing any damage to the uranium mineral. But cannot a process be discovered analogous to chain reactions in chemistry? Let us contrast this process with the case of combustion of coal. Here by raising a small amount to the proper temperature, we ignite the coal, then combustion of the remaining part goes on automatically, provided the supply of oxygen is assured. The heat liberated in the initial combustion, is sufficient to raise the next lying parts to a sufficient temperature, ensuring the reaction to proceed on with sufficient velocity. Can we have a somewhat similar process in uranium fission? Suppose we have a cube of uranium oxide, and in the centre, we put a constant source of neutrons (say a Ra-Be source). Under the present conditions of working most of the neutrons will pass out without causing any damage. They must, therefore, be slowed down. This can be easily done by mixing up paraffin intimately with uranium or taking uranium hydride or deuteride; but slow neutrons appear to be able to react only on U^{235} which occurs in ordinary Ur in the proportion of 1 in 137. However, with the discovery of the new method of separation of isotopes by the process of thermo-diffusion, complete isolation of U^{235} appears to be within the range of practical possibility. In fact, a Swedish engineer was reported to be actively engaged in carrying out this separation. But even when we experiment with a paraffined block of U^{238} , or a hydride or deuteride of U^{238} , with a neutron gun inside it, not more than a small number of neutrons can actually be effective in producing 'Fission'. But in each process of fission 2 to 3 fresh neutrons are produced, and these may cause further fission. We have, therefore, the possibility of having a chain reaction, but the practicability of the idea can be only gauged when experiments have been actually carried out. Experiments of this kind are being carried out in Germany, but no knowledge of progress on these lines is available.

The above process, if it can ever be perfected, can give us an enormous amount of heat. This must not be allowed to occur with explosive violence but should be sufficiently slowed down. After these problems are solved and we get a steady supply of heat,

we can utilize it to feed our machinery for the conversion of heat to electrical energy. So if the efficiency of fission process can be improved, coal mining would be rendered obsolete, but the present system of power engineering would, as far as we can see, remain unaltered.

It is also quite possible that process may be discovered which would render the reactions to proceed with explosive violence. At the present time, nearly several tons of explosives are required to sink a Super-Dreadnought. About 10 million kilocalories, or 10^8 units of energy (Kw) have to be generated

within one hundredth of a second. For getting this energy, we have to detonate a ton of trinitrotoluol, or cordite within a fraction of a second. But this amount of energy is available from the complete fission of only a gm. of uranium. But it is still a far cry whether the whole amount can be liberated within a fraction of a second. Still the idea that a tablet of U^{235} , not more than a homoeopathic globule in size, may blow off a mighty Super-Dreadnought—a feat which can at the present time be performed only by a torpedo carrying several tons of explosives in its head—cannot but be an exciting one.

GLASS FIBRES AND TEXTILES

According to the December issue of the *Fibres and Fabrics Monthly*, the use of glass fibres in the United Kingdom has been so far chiefly concerned with insulating purposes, but in the United States and Canada these fibres are entering a wider field, and, indeed have entered the textile industry proper, being employed in the making of neckties, bedspreads, tablecloths and lamp-shades. It is not difficult to visualise their use in the last named connection: as substitutes for household linen the task is not easy. Apparently also glass fibre awnings are being made for use outside of houses, it being stressed that cleaning the awnings is simply a matter of turning on the hose-pipe. It is claimed with regard to the neckties that they are stain-proof, burn-proof, fade-proof and wrinkle-proof and are available in 45 different colour combinations.

—With acknowledgment to *Bulletin of the Indian Central Jute Committee*.

PLANT AND ANIMAL NUTRITION IN RELATION TO NATIONAL NUTRITION AND HEALTH*

PLANTS are the chief sources of nutrition and energy both for human beings and animals. The ability of plants to manufacture food of the right kind, therefore, is a matter of importance in the nutritional economy of man. During recent years considerable interest has grown in the subject of quality in crops from the point of view of nutrition. Differences in quality may lie in the amount and nature of vitamins present, the biological value of proteins, the presence of certain essential mineral elements, apart from the major food constituents—carbohydrates, proteins and fats. In fact it has now been recognised that even minor differences in the mineral composition of plants resulting from certain environments may lead to profound effects on the health and nutrition of both men and animals.

As early as 1925-26 the author instituted experiments to determine the effect of certain treatments on the composition and nutritive value of common crops with striking results. Organic manures influenced the nutritive value of the plant as well as the seed and the content of accessory food factors of both. Continuing these experiments the interesting fact was established that the nutrition of the mother plant influenced the quality of the seed with respect to subsequent crop production. Cattle manures produced crops of superior nutritive value as compared with those which have had no manurial treatment or only treated with artificial fertilizers. Numerous reports now available in the literature corroborate these findings specifically for vitamin B₁ and vitamin C content.

The superiority of organic manures was ascribed by the author to auximones or vitamin-like growth factors contained in these. This was soon after established by the isolation of three plant growth factors by Kögl and his associates, *viz.*, auxin- α , auxin- β and hetero-auxin, the last being identical with

β -indolyl acetic acid, and all being present in organic manures. Since their isolation in 1933, auxins have provided an interesting field of research and several hundreds of papers have appeared in the literature dealing with various aspects of the subject. The role of micro-organisms in stimulating growth of plant also appears to be due to hetero-auxins they contain. An interesting finding is the growth stimulating effect of thiamin and the appreciable amount in which it is found to be present in organic manures.

While agricultural scientists are engaged in breeding crops of high yields, it is desirable in the interest of national nutrition to combine high yields with high protein content. Generally experience shows that high yield and low nitrogen content go together. Possibly with selection and suitable manuring high yields with high protein content can be secured. It may be possible through improving the yield of high-protein varieties.

In this growing knowledge of the value of manures and fertilizers for the production of food for men and animals the most significant advance has been this new interpretation of the role of organic matter in plant nutrition. Under conditions of hot dry periods of considerable duration and on soils with extremes in texture, and soils deficient in organic matter, such as exist largely in India, organic manures are of special significance. About 25 years ago mineral fertilizers seemed to have solved the problem of agricultural production. These developments in our knowledge have once more awakened the agricultural world to the value of organic manures.

B. A.

* Abridged from Rao Bahadur B. Viswanath's presidential address before the Section of Chemistry and Biology at the annual meeting of the National Academy of Sciences, on February 23, 1941.

PALAEOBOTANY IN INDIA

WE have received the second progress report of work on palaeobotany in India which was originally printed in the journal of the Indian Botanical Society. The report covers the year 1940 and is arranged under the following sub-headings: Carboniferous, Carboniferous and Permo-Carboniferous; Permo-Carboniferous; Permian; Triassic; Jurassic; Cretaceous (?) and Tertiary (?); Cretaceous (?) or Tertiary (?); Tertiary; and Pleistocene.

CARBONIFEROUS AND PERMO-CARBONIFEROUS

Mrs Jacob's work on spores from the Lower Gondwana of India and Australia is rather comprehensive and describes mostly spores, which vary in size and shape and in the presence or absence of wings. A continuous series of transitions can be traced between the two-winged type of spore and the type with one circular wing passing all round the spore.

PERMO-CARBONIFEROUS

R. V. Sitholey (Lucknow) from studies of leaf fragments of *Psygmoxyllum Haydeni* Seward from the Lower Gondwana beds at Dandlutar in the Pir Panjab Range, has been able to attempt to reconstruct a leaf-bearing shoot very similar in habit to *Ginkgo biloba*, although there is no evidence of short shoots.

TRIASSIC

The Triassic flora of the Salt Range is being investigated by R. V. Sitholey (Lucknow). Among the impressions already obtained (reported last year), *Equisetites*, *Sphenopteris* and *Cladophlebis* have been recognised. Bulk maceration has yielded casts of several types of large spores with prominent triradiate marks. Some of these are being described as new species of *Triletes*.

JURASSIC

K. M. Gupta (Surat) has described a well preserved specimen of *Williamsonia* from Khairbani in Bihar. Parts of the specimen are seen as impressions and parts are preserved in a solid form as a petrification. Impressions left on the rock are closely

comparable to *W. Sewardiana* Sahni, with which it also shows other points of resemblances.

Miss Janet (Lucknow) working on fragments of carbonaceous state received through D. N. Wadia, from Andigama in Ceylon, has recovered a variety of microscopic remains of plants and animals. The microflora includes several kinds of spores, some cuticles and a few filamentous plants of unknown affinity, possibly fungus mycelia. The work is still at a very early stage. But it is worthy of note as the first contribution to our knowledge of fossil microflora and microfauna of Ceylon.

TERTIARY

Palaeobotanical evidence for an early Tertiary age of the Intertrappean beds of the Deccan is steadily increasing. B. Sahni concluded his Presidential address at the Indian Science Congress in 1940 by saying that 'From what we know of the geological history of the stoneworts, the fungi, the water-ferns and particularly the palms, which formed such a vast proportion of the flora, everything seems to point to a Tertiary age. What is more, the fishes and the crustaceans, too, seem to fall into line with the plants'.

From the Intertrappean beds of the Central Provinces V. B. Shukla (Nagpur) has described a well preserved specimen of dicotyledonous wood with a structure closely comparable to the modern *Casuarina*.

PLEISTOCENE

Detailed investigations of C. S. Middlemiss's collections of 1910 from Ludarmang (Pir Panjab Range) at the altitude of 10,600 feet and H. de Terra's collections of 1932 from the same locality are in progress. More than 40 species belonging to 30 genera distributed over 22 families of modern plants have been described. Quantitatively the best represented is *Quercus* and the great abundance of oak leaves suggests the probability of an oak forest in the locality. The study of this flora promises far-reaching conclusions which are likely to throw light on the Ice Age in Kashmir.

Notes and News

Leonardo da Vinci Exhibition at the New York Museum of Science

THE New York Museum of Science and Industry recently arranged an exhibition of the scientific achievements of Leonardo da Vinci, where a collection of 275 working models of his more important inventions in the realms of science and engineering were displayed. The world has known and honoured Leonardo da Vinci as one of the greatest artists of all ages. Few are aware that his achievements in the fields of science, engineering and invention were as great as, if not greater than, that in art, and in these spheres he was one or two centuries ahead of his time. Though he never published anything during his life time, during his unceasing and varied activities he penned down notes of what he was doing. Of these writings, 7000 of the original sheets have been preserved in different libraries of Europe. These manuscripts cover an amazingly wide range of subjects, e.g., aeronautics, astronomy, botany, palaeontology, geology, physics, mathematics, engineering and sculpture. Not that he was a dabbler in any of these lines but was far ahead of any master of his time. Researches among his manuscripts, which began towards the close of the last century and are still going on, have shown that he anticipated discoveries in many spheres. He was a pioneer in many branches of science—an anticipator of Galileo, Newton and Harvey. Many of his manuscripts are found to be illustrated by clear and definite sketches and drawings and it is from these sketches that the 275 working models of Leonardo's inventions recently exhibited were made. The collection of models include a helicopter, a double-hulled ship, a pile driver, a power-driven bandsaw, a canon actuated by steam,* the rolling mill, force pumps and lens-grinding machines and such modern weapons as breech loading canons, rapidfire multiple canons and machine guns and the terrible engine of war—the tank. These models leave the impression that Leonardo was an artist fully at home in the world of machines. His work in these

fields did not receive the due share of recognition because he did not publish them and also because he was born in an age when people in general were not prepared to see the value of science.

Work of the United States National Museum

THE report on the Progress and Condition of the United States National Museum for the year 1939-40 gives a brief account of the work accomplished in its various departments and also gives detailed reports of its new collections in the department of anthropology, biology, geology, engineering and industries, etc. A complete list of accessions and Museum publications during the year is included. Additions to the collections were many and varied during the last year most of them coming from expeditions arranged through the Smithsonian Institution. Lots of specimens were also received for examination and report. As usual gifts of duplicates were made to schools, museums and other institutions. In its different departments the Museum at present contains a total of 17,001,199 specimens. Field work of the staff went on as usual.

Dr Ales Hrdlicka made an anthropological trip to Europe, his chief objective being to study and examine skeletal and cultural materials in Russia and Siberia. He had the privilege of studying the skull and remains of bones of a Neanderthal child found in Uzbekistan in Central Asia. Archaeological studies were continued in Western Kansas by Dr Wedel. Dr Dale Stewart continued systematic excavations at the site of the Indian village in Stafford County, Va. Dr Foshag collected some rare minerals in Mexico. Notable collections of birds and mammals were made from North Carolina and herpetological fauna from Mexico. Large collections of fishes, mollusks and other marine invertebrates and reptiles were made by the Naval Expeditions to the Phoenix and Samoa Islands. Captain Robert A. Bartlett brought valuable invertebrate collections and Arctic plants from his expedition to Greenland waters.

* Leonardo anticipated the use of steam and sketched a steam canon.

The educational activities of the Museum were carried on in the usual lines. Replies to hundreds of inquiries were made and students from that country as well as from abroad were allowed to work with the collections in the Museum. The staff of the Museum supplied materials for a weekly educational broadcast entitled, "The World is Yours". The library of the Museum is gradually expanding, the present collection containing 99,323 volumes and 117,516 pamphlets and charts.

Prevention and Cure of Mental Diseases

AN association called the Indian Mental Welfare Association has recently been formed in Calcutta with the object of offering relief to the people suffering from mental diseases and deficiencies. The sufferings caused by mental diseases and disorders are no less than that caused by physical ailments. Still the Government and the public in this country extend their sympathetic hands for the medical relief of these suffering from physical diseases only, caring very little for the sufferings of the mentally afflicted. In the U. S. A. the hospital accommodation for mental patients is about half of that for patients with physical diseases. In England, in London alone there are 34,000 beds for mental patients in hospitals. Census figures (1931) for the insane in Bengal is 22,402 and it is a pity that Bengal has only a share of a mental hospital with three other provinces. There are however at present two or three private and poorly financed institutions only for the cure of the insane in and around Calcutta and one for the feeble-minded. But there is lack of systematic attempt to evolve a common plan and to co-ordinate the activities of these. The newly started Mental Welfare Association will serve a very useful purpose as it proposes to tackle the problem of mental diseases in the country both in its preventive and curative aspects. The Association has already organized public lectures to educate the public in mental hygiene and has arranged for instruction of school teachers so that they may detect early mental abnormalities in school children. The Association further intends to establish a well-equipped modern mental hospital under trained experts. The Government and the public should make generous contributions which alone will make it possible for the Association to carry on its very useful projects.

Indian Statistical Institute

THE Indian Statistical Institute has completed nine years of its useful existence. The report on the working of the Institute presented before the annual general meeting held on the 24th April last, gives a

review of the activities of the Institute covering a vast and varied field. The following were elected office-bearers of the Institute for the next year: *President*, Sir Badridas Goenka, *Vice-Presidents*, Dr P. N. Banerjee, Mr J. H. Burder, Sir A. H. Ghuznavi, Dr T. E. Gregory, Dr J. Matthai, Dr S. P. Mookerji, Dr C. W. B. Normand, Sir Shri Ram, Sir C. V. Raman, The Hon'ble Mr Justice T. J. Y. Roxburgh and Mr N. R. Sarker; *Treasurer*, Dr S. C. Law; *Secretary*, Prof. P. C. Mahalanobis. The Indian Statistical Institute has recently taken up a very useful work, namely, a scientific survey of public opinion on different problems in India. Prof. P. C. Mahalanobis in a recent article published in the *Modern Review* has described experiments conducted in America for successfully ascertaining public opinion by use of statistical methods and has discussed the applicability of these methods in India. Such scientifically conducted surveys of public opinion will help to distinguish genuine public opinion from interested propaganda and will also check some of our politicians and publicists to make unjustifiable generalisations and conclusions on too meagre data. We hope the Indian Statistical Institute will receive the help and co-operation of the general public in its laudable attempt to carry out from time to time scientifically organised survey of public opinion and preference in India.

Research in Physical Sciences During 1940

PROBLEMS of war and defence having occupied the attention of scientists the world over research in applied sciences were somewhat accelerated while searching for knowledge in other fields were comparatively slowed down during 1940. As for example, much improvement was affected in the construction of aeroplanes. Aircooled airplane engines developing more than 2,000 horse power were developed. Military airplanes attained speeds exceeding 400 miles per hour. A new interceptor fighter plane capable of ascent at a speed of more than a vertical mile a minute was demonstrated. Of the work done by physicists mention may be made of the isolation of minute quantities of uranium 235, the isotope which when once started disintegrating by bombardment with suitable projectiles continues the process with the liberation of tremendous amounts of energy.* Electron microscopes having magnifying power many times greater than optical microscopes were commercially produced in the United States. Wireless power transmission through small distances was successfully carried out with the help of Klystron tubes.

In the domain of nuclear physics, measurements of the binding energies of protons and neutrons were

* See article on Uranium Fission on p. 694 of this issue.

carried out in the nuclei of certain atoms. Neutrons were found to be associated with cosmic radiations and photographs were obtained showing the decay of mesotrons into ordinary electrons confirming previous predictions. Television by radio in natural colour was accomplished last year. Pressures as high as 3,500,000 pounds per square inch were obtained in laboratory experiments to create the condition existing far underground.

A very important achievement in synthetic chemistry was the duplication in the laboratory of the natural process by which glucose is converted into starch in plants. A method was also discovered by which coal and oil can be made in the laboratory from plant carbohydrates thus doing in a few hours the work done by nature in millions of years.

Incendiary Bombs used in the Present War

IN the recent Nazi raids over London and other parts of England more damage has probably been done by incendiary bombs than by explosive ones. Incendiary bombs were used for the first time during the last great war but they were mostly ineffective as the ignitable material used in them, namely, thermite and liquids like gasoline were very quickly burnt out. This time two entirely new types of incendiary bombs called the electron bombs and multiple-effect bombs are being used with much greater success. In the electron bombs there is a charge of thermite inside a shell of electron metal consisting of 80 per cent. magnesium and 20 per cent. hardening metal. The magnesium shell is the principal incendiary material and thermite only starts the ignition when the bombs strike the objectives. The shell burns for 10-15 minutes at a temperature of 1500°C. The weight of these bombs range from one to twentyfive kilograms, the lighter ones being used in large numbers for indiscriminate bombing and the heavier ones being used against specific targets, such as munition dumps or factories. Electron bombs are best extinguished by smothering them with powdered talc, dry sand or other such granular materials. In England a special smothering device called a 'snuffer' made of wire mesh sprayed and covered with asbestos has been successfully used.

The other type, the multiple-effect bomb contains separate incendiary units which scatter over a wide area upon impact. They are usually heavy and used in the bombardment of specific objectives.

New Method of Producing Quick Revolutions

DR L. E. MACTATTIE of the University of Virginia has invented a method of magnetically suspending a steel ball $3/32$ inch in diameter in

vacuum and spinning it at the rate of 110,000 times per second, about 3000 times as rapidly as a fast aeroplane propeller. The method practically eliminates friction and air resistance and offers vast possibilities. In many physical researches a rapidly rotating mirror is needed and the applicability of the above method for such purpose was tested by grinding two flat faces on the ball 100,000 times per second without in any way damaging it. This method may find an important application in the separation of 235, the power-producing isotope from the ordinary element. Minute particles and even molecules differing slightly in weight can be separated by the ultra-centrifuge which as is well known employs a spinning device. Sufficiently large rotary speeds will make possible the separation of isotopes by an ultra-centrifuge. For the separation of uranium isotopes a speed of 66,000 revolutions per minute will suffice. Though this is small compared to the rotary speed attained by steel ball in Mactattie's experiments, the task of uranium separation presents a much more difficult problem because in this case the rotating cylinder must be several inches in diameter whereas in his experiments Mactattie used a ball of only $3/32$ inch diameter.

Synthetic Food for Proper Nutrition

To combat against nutritional deficiency the German soldiers engaged in the present war are supplied with vitamin biscuits in addition to their ordinary rations. In the U. S. A. attempts to develop a 'synthetic' food to enable even the poorest among the population to remain in a good nutritional condition have met with success. Prof. Robert S. Harris of the Nutritional Laboratories at the Massachusetts Institute of Technology has developed the 'synthetic' food by compounding several quite cheap basic foods containing all the necessary nutritive elements. Deficiencies in the diet of the poorest section of the population in that country was found out by comparing the actual intake of the different nutritive elements by them with the optimum requirements. Two or three different cereals, like wheat, soyabean, oats or corn, cheapest among human food-stuffs when properly blended together can provide a protein mixture as good as that in milk or eggs, each component supplying some vitamins and minerals. The gap is filled by pure mineral salts and vitamin concentrates or synthetics. The resultant mixture, in flake form, provides a quite palatable food and less than an ounce daily will keep a person in good nutritional condition. However unbalanced the nutritional value of individual diet may be if the above dose of 'synthetic' food be taken by the general public, nutritional deficiencies will be altogether

avoided. Manufacturing cost of the food for one person is estimated at 1'8 dollars per year.

Geological Studies of Ocean Muds

DR JOSHEPH A. CUSHMAN, director of the Cushman Research Laboratory, Massachusetts, and a noted authority on marine biology has pointed out the importance of studying ocean muds for interpreting their geologic history. Mud deposits on the deeper parts of the ocean floor represent the accumulation of all geologic ages. Thickness of deep ocean deposits grow at the rate of less than one centimetre in 1,000 years, so that the actual layer of sediment nearly 500 feet thick in some parts of the ocean floor, represents a time interval of nearly 2,000,000 years. The Piggot Gun recently invented by Dr C. S. Piggot of the Carnegie Institution of Washington has made it possible to collect vertical core samples 10 to 12 feet long from deeper parts of the Atlantic Ocean. Mud samples obtained along the Atlantic cable line from Newfoundland to Ireland are found to contain fossil remains of tiny life forms, diatoms and foraminifera, which reflect climatic conditions prevalent at the time of their deposition. Alternations of cold and warm types of foraminifera somewhat corresponding to the known advances and retreats of the great ice sheet that once covered the North American continent have been found. Mud samples taken from the Caribbean sea also show definite zones of concentration of warm water foraminifera separated by zones in which they were absent.

Work of Veterinary Research Institute

POULTRY farming is receiving increasing attention, says the annual report of the Imperial Veterinary Research Institute for the year 1939-40. In the Poultry Research Section of the Institute at Izatnagar, breeding experiments are being conducted with White Leghorns and Rhode Island Reds and with *deshi* (or native) fowls. The experiments have reached the second generation. It is proposed to try these breeding experiments under village conditions. Poultry foods are also being analysed. Feeding trials have brought out the advantage of separated milk over water for the growing bird in reducing mortality and improving the growth rate. Soya bean and earlnut are good substitutes for milk. The present method of prophylaxis against *sp. anserina*, by which healthy birds are inoculated with infective blood and treated with atoxyl 24 hours later, has been found to be satisfactory.

Experiments have been started on the relationship between different levels of carotene feeding to milch cattle and the concentration of carotene and vitamin A in the milk and in the intestinal and urinal excretions. It has been found that the protein content of grass is not affected when it is dried at a high temperature or in the sun; there is, however, great loss of carotene by sun drying. Diet experiments on heifers revealed that protein deficiency led to deterioration in growth and the development of 'fits'. Other observations confirmed the importance of vitamin A to the pregnant animal and that vitamin A deficiency led to 'night blindness' in calves. It was also observed that the vitamin C content of the tissues was greatly reduced in certain diseases like rinderpest, worm infestation (in horses) etc. As farm animals are known to be capable of securing their own vitamin C independent of their diet, it is inferred that diseased animals become incapable of producing a sufficient quantity of the vitamin. The problem is now under study.

During 1939-40 the Institute supplied 31,22,000 doses for the prevention and cure of diseases of domestic animals in the shape of sera, vaccines and diagnostic agents, which realised Rs. 4,55,000/. Mallein, used in testing ponies for glanders, is now being manufactured as a routine by growing the bacteria of the disease on synthetic media. This should obviate the troublesome tests for the study of non-specific reactions.

From 1940 the Institute is providing more instruction to post-graduate students in the form of two courses, one in advanced animal husbandry and another in poultry husbandry, in addition to the annual post-graduate course in veterinary science and practical courses of training to suit individual requirements.

At Izatnagar a central museum is to be set up which will give visitors a scientific insight into the field now covered by veterinary science, including animal husbandry. It is also hoped to establish a wool research laboratory and laboratory for problems connected with hides and skins.

Archaeological Survey of India's Annual Report

THE Annual Report of the Archaeological Survey of India for the year 1936-37 has been recently published. This is the last of the series of voluminous reports with the rich get-up that was characteristic of this publication. In future the conservation of monuments and other activities of the department will form part I of the report with a paper cover, while excavations and other scientific

material will be relegated to a handier well-illustrated volume called part II. One report of the new series will soon be available to the public.

During the year under review in the field of exploration the most important discovery was that of a colossal temple with multiple terraces and angles datable to the early centuries of the Christian era at Lauriya Nandangarh in Bihar, already reported on pages 349-350 of this journal. This temple is the earliest prototype of the architecture of Burma, Java and Siam and is regarded as the oldest architectural model. The work was carried out by the late Mr. N. G. Majumdar, whose premature death has deprived Indian archaeology of a devoted explorer.

A number of ruins were explored in the jungles of Assam, and some material of archaeological interest was discovered at Pagan and old Prome in Burma.

As regards conservation, the reconditioning of the Gol Gumbaz at Bijapur, the biggest dome in India, was the principal work done during the year. Special repairs were made to (a) the Taj Mahal at Agra; (b) the Imambara of Asaf-ud-Daula at Lucknow and (c) the ancient Buddhist ruins at Sarnath near Benares. At Delhi, the Lodi tombs received special attention in view of the lay out of the Lady Willingdon Park.

In the epigraphical branch the most important discovery is that of the earliest inscriptions found with three Brahmi inscriptions from Kosam, ancient Kausambi in the Allahabad district, one of which dates from the 2nd century B.C. Much material was collected in Central India, Rajputana and South India. A specially important feature of this year's collection is the discovery of a number of copper-plate records which throw interesting light on the history of early and medieval India.

In the field of museums, a detailed scheme whereby a number of museums in all provinces throughout the country should benefit by receiving duplicate representative sets from Mohenjo-daro was launched during the year.

Annual Report of Botanical Survey of India

THE annual report of the Botanical Survey of India for 1939-40 has been published. During the year nearly 3,500 specimens were identified and revised, of these about 800 plants belonged to the

Forest Research Institute, Dehra Dun, and 702 Burmese specimens were received from Dr. E. D. Merrill of Harvard University, U.S.A. The rest were sent by various Government Departments and educational institutions and private workers in India and abroad. This year there was unfortunately severe restriction on loan of herbarium specimens owing to overseas transport difficulties. Several hundreds of flowering plant specimens and ferns have been collected from different part of Bengal.

As a result of monographic studies conducted according to the International Rules of Botanic Nomenclature, the names of several flowering plants of India have been revised. The assistant for India at Kew continued his series of noteworthy plants of South India, Assam and Burma. A large number of new species of flowering plants and ferns were described and published by various authors during the year under review.

More specimens of Indian silk products, industrial oils and oilseeds, food products, plant specimens of reputed insecticidal properties, hand-made paper exhibits and medicinal plant products have been added to the Industrial Section of the Indian Museum.

As already noted in these columns, investigation have shown suitable localities in India for the cultivation of Ipecac (*Cephaelis Ipecacuanha*), a widely used vegetable drug and one of the few known remedies for dysentery. A considerable quantity of the crude drug is now imported. Similarly an enquiry made on the Tung oil yielding plants in the probable centres of cultivation revealed considerable possibilities for the industry in India. There is ample scope for the manufacture of papain in India from the milk juice of the common papaya fruit, says the report.

An economic survey of the forest wealth of Mayurbhanj State, is being carried out by the State under the guidance of the Curator of the Industrial Section of the Indian Museum. The commercial public were supplied with information on the sources and supply of economic plant products, such as fibres, resins, tanning materials, varnish oil, vegetable dyes, insecticides and medicinal plants.

Workers in universities and other institutions both in India and abroad were supplied with different plant materials for their research work and the results obtained were in most cases communicated and recorded.

SCIENCE IN INDUSTRY

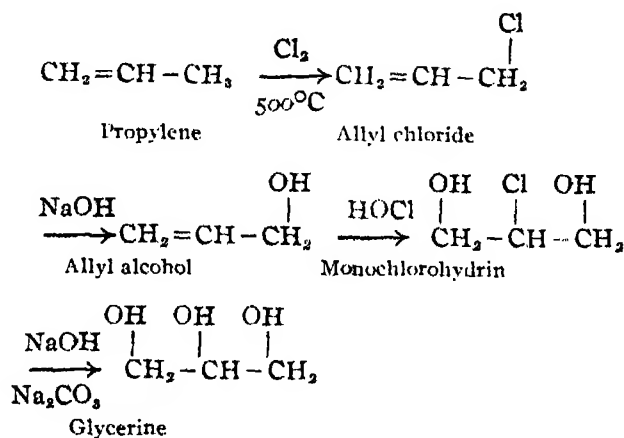
Glycerine Synthesised from Petroleum

THE world supply of glycerine under normal conditions is obtained as a by-product from soap industry, that is from processes of hydrolysis or saponification of natural oils and fats. During the last war, efforts were made in Germany to produce glycerine from other sources and she actually produced 13,000 tons per year by fermentation, a process which received considerable attention. The process is essentially a modification of the ordinary alcohol fermentation, in which by varying pH by the addition of suitable salts, the amount of glycerine formed is increased. Commercial difficulties for this process are concerned chiefly with the rectification to a high grade product in an economical way. It is further tied up with the production of a considerable amount of alcohol.

Recently the research workers of the Shell Development Co., U. S. A. have developed a process for the economic manufacture of glycerine from petroleum. We published a short note on this some time ago. In a recent article in the *Chemical and Metallurgical Engineering* a brief outline of the synthetic manufacture of glycerine from petroleum as developed by the Shell Development Co., has been described. Since glycerine is one of the basic raw materials for explosives some eminent chemical engineers have termed the development of the process as the most significant chemical achievement since the fixation of nitrogen by Haber during the last war. The process has passed the pilot plant stage and a big plant is under construction.

The starting material is propylene obtained by rectification of refinery cracked gases. Propylene of 98 per cent. purity is satisfactory for ordinary purposes. Propylene is converted to allyl chloride by direct chlorination at 500°C. This "hot chlorination" process is of particular importance here. This allyl chloride is then hydrolysed to allyl alcohol, which in its turn undergoes the process of chlorohydrination in aqueous solutions to form glycerine monochloro and dichlorohydrin. These chlorohydrins on further hydrolysis are converted to glycerine. In commercial practice the allyl alcohol step can be

dispensed with since allyl chloride can be directly converted to chlorohydrins. However, since allyl alcohol, is an important product itself, the hydrolysis step was fully investigated. Flow diagram for the reactions is given below :—



For the formation of allyl chloride from propylene the percentage yield is of the order of 85 per cent. and the overall yield of finished glycerine from allyl alcohol or allyl chloride is about 90 per cent.

N. K. S. G.

Explosive Ink

SPEED of newspaper presses can be much increased if an ink were available that would dry instantly. Startling results followed the initial experiments of an inventor in his efforts to prepare such an ultra-rapid-drying ink. According to a paragraph in the *Manchester Guardian*, the first trial of such an ink was so successful that it set with the suddenness of an explosion and ruined the apparatus that was being used. However the principle was all right, and the inventor succeeded in slowing down the setting process. The ink which has now been patented, is described as a dihydric alcohol polyester

of an unsaturated dicarboxylic acid of the fumaric-maleic or citraconic-mesaconic-itaconic groups.

N. K. S. G.

Utilisation of Blast Furnace Slag

THE production of pig iron in the blast furnace is accompanied by the production of slag, which is a source of waste to the metallurgist because it represents wasted material and wasted heat. Amount of slag produced per unit weight of pig iron depends on the quality of the ore. The quantity of slag available when making iron from haematite ores is from 1200 to 1400 lb. per ton of iron; from foundry iron it is 2400 to 3000 lb. per ton; from basic iron 2500 to 3200 lb.; a fair average is one pound of slag per pound of iron. In other progressive countries formerly it was dumped on huge mounds which required space and entailed haulage and labour charges. In our country it is the practice yet; but other countries have developed various uses of slag since proper utilisation of this means lesser production cost for the iron. Useful information as to the utilisation of this material in the U.S.A., has lately been published by W. H. Caruthers in a paper to the Industrial Minerals Division of the American Institution of Mechanical Engineers.

The utilisation of slag depends on its properties. It has more bonding surface per unit area than any other commercial mineral aggregate because of the countless bubbles of gas that are entrapped in the molten mineral as it cools, causing the faces to be pitted in every individual crushed piece. It will not absorb water through these pits and become saturated because the pits are not interconnected.

The latest U.S.A. figures for the use of slag are as follows: railway ballast, 22 per cent.; traffic bound roads and concrete pavements, each 16 per cent.; water-bound macadam 14 per cent.; structural concrete 13 per cent.; bituminous roads and road maintenance 15 per cent.; miscellaneous uses 4 per cent. Among the miscellaneous uses, the development of which are gradually increasing, are the construction of the "twenty year" bonded pitch and felt roofs that have been recently developed in the U.S.A. and the use by the Flintkote Co. as a roofing material in which dyed slag granules are used for surfacing. It is stated in the above paper that these granules retain their dye colours satisfactorily when exposed to the weather.

The most interesting recent development is the production of Portland cement from blast furnace slag. It is expected that in future this single use will surpass all other uses. There is a marked similarity in composition between blast furnace slag

and Portland cement as is shown in the following table:—

Analysis of 600 Slags				Analysis of 32 varieties of Portland cement.
Constituents	Max.	Min.	Average	Average
SiO ₂	55.72	25.30	36.36	21.9
Al ₂ O ₃	19.43	5.46	12.76	5.9
CaO	48.06	25.82	41.15	62.9
FeO	2.83	0.25	0.75	2.9
MnO	9.67	0.04	0.91	<i>nil</i>
MgO	19.86	0.10	6.57	2.6
S	5.06	0.16	1.45	1.7

There is much controversy regarding the production of cement from blast furnace slag. The British Ministry of Works maintains that satisfactory slags, suitable for cement, can only be produced from working on haematite ore. But the majority of cement experts are of opinion that a suitable slag for cement manufacture can be produced by modifying materials which are charged into the blast furnace. The latest developments in U. S. A. are such that the blast furnaces are operated with the dual object of producing the best possible iron and the best possible slag. The slag should be cooled rapidly to furnish a hard resistant material. In actual practice, the molten slag is run into a rapid stream of cold water whereby it is obtained in the granulated form. In some cases limestone and slag are separately crushed and dried, and then mixed and ground together in correct proportions; this raw mixture is burnt to clinker in a kiln; the clinker is then mixed with a suitable proportion of granulated slag and ground to cement fineness for use as cement. In U. S. A. the slag cement is an intimate mechanical mixture of blast furnace slag with 30 to 40 per cent. of hydrated lime, no heat being used. In Portland cement, the slag is used as the siliceous material and less limestone is needed than when clay or shale is used because the slag contains both lime and silica.

Another use for slag is the slag wool which was first made in the U. S. A. in 1870, and there has been a striking growth in this industry within the past thirty years. Mr. Caruther's paper also informs that attempts are being made to produce glass from slag. Experiments show that with proper admixture of arsenic, soda, etc., slag glass can be produced of almost any standard, and with many superior qualities.

N. K. S. G.

Revival of Natural Dyes

RAPID strides are being made by scientific and industrial research to make India produce vegetable dyes particularly useful at this time.

New natural dyestuffs have been produced from the barks of mango, babool, jamun, dhak, pipal, bor, plum, maltas, tamarind and fig at the Government Silk Institute, at Bhagalpur in Bihar. These dyestuffs are also obtained in powder and paste form. By using different fixing agents with the same powder, different shades have been obtained.

Work on derivatives from Kamela flowers for use as edible colouring materials has been completed at the H. B. Technological Institute, Cawnpore. The Indian Jute Mills Association is investigating the possibilities of special dyeing methods and intend to produce sack marking ink; the University of Mysore is trying to use myrobalans for manufacturing dyes.

The Government Textiles Institute, Madras, has worked out successfully methods of dyeing with several natural dye-yielding products of indigenous growth. They were in vogue prior to the advent of synthetic dyes but unfortunately the processes were all forgotten.

While the present research is expected to yield vegetable dyes, the activities of the Bararee Coke Company which manufactures benzene, toluene and phenol and the proposed installation of a big plant for the recovery of these products at Tatanagar will eventually lead to the production of innumerable organic compounds and drugs and may turn out to be the forerunner of a synthetic dyestuffs and drugs industry.

With a view to reviving the industries on vegetable dyes, the Board of Scientific and Industrial Research has set up an exploratory committee on vegetable dyes, as a result of whose labours, it is expected that more vegetable dyes would be in use.

Tube-Well Waters of Calcutta

THOUGH water from tube-well is generally reliable and satisfactory from the bacteriological point of view, complaints are heard with regard to its chemical behaviour. Tube-well water may cause an excessive consumption of soap in washing or delay in cooking, destroy to some extent the colouring matter of tea resulting in a mixed colour which is disagreeable in appearance, tarnish household brass and copper utensils and sometimes may deposit a white layer on glass vessels and finally taste saline. Of course complaints against one

tube-well are not made generally on all these points. They usually crop up singly. When therefore a plan is adopted for supplying drinking water to the people of a large area from tube-wells, it is necessary that a proper survey should be completed first by trial borings and then after proper arrangements for avoiding the defects the scheme should be put into practice.

The sodium chloride content of the tube-wells in and around Calcutta is discussed in the latest *Memoir* of the Geological Survey of India. On the basis of chemical composition, the waters of the shallow tube-wells not exceeding 432 feet in depth in and around Calcutta have been found to fall under four different types.

The reason for these differences in type, it is suggested, is that in these comparatively shallow depths the water bearing strata of the four regions are different from one another and are replenished by water from different sources. In the first region, the source is the sub-soil water derived in its turn from rain water; in the second region the character of the sub-soil water is largely altered by seepage into it of the water of the Salt Lake, situated on the east of the city; in the third the sub-soil water is replenished by fresh non-saline Ganges water while in the fourth the influence of marine conditions is manifest.

The difficulty with regard to variable sodium chloride content in a particular tube-well in Calcutta which was first investigated, has been remedied by reduction of the pumping hours by half, thereby allowing sufficient rest for the bed to prevent the preponderance of any flow in the underground region.

Chemical Constants of Lac

THE determination of chemical constants of a substance is one of the methods of its identification and the only method for estimating its degree of purity. Acid, saponification and hydroxyl values of lac hitherto differed according to different workers and these have been recently determined after a systematic study at the London Shellac Research Bureau. The bulletin on the subject shows that the acid value of lac has been determined with three different indicators. Alkali Blue 6B as an internal indicator gives a sharp end point, and it has been found preferable to use 0.1N alcoholic potash for titration instead of the customary 0.5N. To effect complete saponification, at least four hours' heating on a water bath with 0.5N alcoholic potash is necessary. Further complete saponification could not be obtained with absolute alcoholic potash; the presence

of water is necessary; and optimum results are obtained with 10 per cent. of water in the alcoholic potash. For determination of the hydroxyl value of lac, Normann's method has been found convenient and gives reliable results but it is necessary to allow at least four hours' refluxing with 0.5N 90 per cent. alcoholic potash to saponify completely the acetylated lac product.

Brazil growing Jute

FOLLOWING the news of successful experimental cultivation of Jute in the U. S. S. R. published in these columns, we learn that Japanese colonists in Brazil expect to raise more than 1500 tons of jute this year. It may be noted that the Brazilian Government abandoned their experiments on jute cultivation which were started in 1925. Afterwards an amateur Japanese agriculturist sowed some jute seeds in the spring of 1936 and only two freak jute plants grew on the mashlands along the Amazon river. But one of these died in the flood and the other attained a height of over 12 ft. and bore some seeds. The same year during the autumnal rains the seeds were sown and crops have since increased yearly. The farmers there are now arranging to substitute coffee raising by jute cultivation.

Paper from Indian Materials

THE quinquennial review of forest administration in British India ending 31st March, 1939 which we have received, reports the progress made by the paper pulp section at the Forest Research Institute. As a result of their investigations a mill has already produced kraft paper from bamboos, though its strength is yet to be improved. Complete data on the digestion and bleaching of a few species of bamboos were obtained on semi-commercial scale. Besides, work is in progress for production of wrapping and packing papers from *Anthisteria gigantea* (ulla grass, and *Pinus longifolia* (chir) is also tried. A pulp grinder is operating since 1937 to explore the possibilities of establishing an industry for the manufacture of newsprint and other cheap printing papers. Mechanical pulp constitutes 70 per cent. to 80 per cent. of newsprint and after trial with four varieties a broad-leaved wood, *Kydia Calycina* has given satisfactory results.

There has been in recent years closer co-operation with the paper industry. The Paper Makers' Association have given financial help for researches. A few mills sent people for training in pulp and paper technology and technical advice was sought by some other mills. The Forest Research Institute Laboratory produced about 18 tons of paper

and boards which have been utilised by them and other government agencies.

Discovery of Strontium in Madras Province

STRONTIUM, allied to calcium, occurs in commercially important deposits in the form of celestite (the sulphate) and strontiate (the carbonate). Strontium compounds are used in cathode-ray tubes and other devices for the emission of electrons, in medicinal preparations, in refining beet-sugar, in pyrotechnics, flares (for railways, especially in the United States), tracer bullets and signals for ships and aeroplanes in which the bright crimson imparted by the element to a flame is utilised. Strontium sulphate (powdered celestite) acts as a brightening agent in coloured paints and as a filler it finds use in sealing compounds for electric batteries, asphaltic compositions, rubber, sealing wax, etc. The Imperial Institute, London, estimates that 2,000 to 4,000 tons of celestite are used annually as paints and fillers in Great Britain. Powdered celestite is said to be suitable for making water-paint distemper.

Strontium carbonate is used in Germany to produce special high-grade alloy steels, and is also used to a limited extent in the manufacture of glass, ceramic glazes and enamel. Strontium chloride powder is employed in refrigerators working on the solid absorption principle.

India imports several tons of celestite per annum for military use and for pyrotechnics and medicinal preparations. One million tons of this mineral have been found to occur in the Trichinopoly District, Madras Province by officers of the Geological Survey of India after investigations in the season 1939-40. Celestite was recorded in this area by Dr H. Warth, who was then superintendent of the Government Museum at Madras but was since forgotten.

The world's biggest deposits of strontium occur in the west of England and these, together with German celestite, have furnished the world's requirements so far. The production from several deposits in the United States is comparatively small, since the domestic product finds it difficult to compete with the long-established British and German industries. In the Trichinopoly District, celestite occurs as sparsely distributed veins in the gypsum-bearing clays of Cretaceous age over an area of about 10 square miles and the quantity available has been estimated within a depth of 100 feet from the surface. The mineral also occurs in Upper Sind and in the Kohat District of the North-West Frontier Province but (as in the cases of France and Italy) not in commercially important quantities.

Position of Essential Oil and Perfumery Trade in India*

P. APPAJI RAO

IN this discourse I should like to bring to your notice a few facts concerning the requirements of essential oil and perfumery trade. By trade requirements I mean not merely the sale of the products in this line, but also the needs of properly trained tradesman, properly trained laboratory chemist and the properly trained manufacturer. At the present moment all these three are looking at each other in tangential ways. In the first place the trader in the bazar does not care to know who manufactures the goods, what is its quality, and how he can serve the public. He is concerned only with his own profits irrespective of the interest of the consumer or of anybody else for that matter. The chemist in the laboratory with his proud knowledge of molecules, associations and dissociations, is blissfully ignorant of market conditions, is forgetful more or less of the economic difficulties of the manufacturer and is only after his own pet abstract themes. Lastly comes the manufacturer who is always being dictated to by the capitalists and who also is forced to ignore the scientist's help as much as possible. A manufacturer in Europe is fortunately free from this kind of constant trouble. Further a very well deserved lesson which an Indian manufacturer has to learn from his foreign colleague is in the matter of treatment meted out to a representative of the firm. To a manufacturer in Europe the salesman is a *producer of wealth* and as such he (salesman) is treated with a generous and broad outlook. Unfortunately an Indian salesman with an Indian manufacturer does not receive that courtesy and sympathetic hearing which are at the root of considerable progress or retrogression of the firm concerned.

Taking all these into account the essential oil business is one which requires a thorough grasp of the realities of the situation. Unlike other business it requires a manufacturer who has a well developed aesthetic taste, eye for beauty, and an exact knowledge of the consumer's inclination. We all talk in loose terms that India can produce and can imitate other countries if sufficient capital is available. It has to be remembered that in running any factory the role of the capitalist is only one-third, the role of the

salesmen (in other words, market contact) is a second one-third and the last one-third is made up of all the technicians (which term includes chemists, chemical engineers and other scientific experts). It is only a harmonious combination of the capitalists, the traders and the technicians that can make a successful manufacturer. A mere imitation of what other countries are doing is not advisable though a keen lookout of what others are doing is a beneficial stimulant for our own guidance. The essential oil industry is one which requires a good deal of hard thinking before establishing a factory. Most of the essential oil bearing plants yield one to three per cent. of a particular essential oil; the utilisation of the rest of the material is a big problem. The bye-products that are available yield quite a decent return for any such extra investments of money as are found necessary. One of the reasons why there are not many essential oil factories in India is that our capitalists and industrialists have not got the patience to wait and watch the results but on the other hand are very anxious for immediate returns as for instance in the case of sugar cane factories. For an essential oil factory to be run successfully a minimum capital of rupees fifty lakhs will be required. The object of suggesting such a figure will become quite obvious when one takes into account the following organisational components:—

- (1) An independent organisation for gathering the raw materials from various parts of India.
- (2) An organisation for disposal of all the bye-products both in an unfinished and finished conditions in a profitable way.
- (3) A selling organisation throughout the length and breadth of India to keep the laboratory informed from time to time what product or products are saleable in each specified territory so as to regulate the output of the factory during the full twelve months of the year.
- (4) An extensive plot of land in a suitable place or places for experimental cultivation of a few items on a semi-commercial scale.

* Adapted from a lecture delivered by the author on April 7, 1941, at the Acharyya Jayanti Exhibition organised by Calcutta Corporation Commercial Museum.

- (5) An up-to-date laboratory equipment where in a botanist, a biologist, a pharmacist, an organic chemist and a chemical engineer can work harmoniously together under one cover to consider the problem as a whole.

With a company of this type it will also be necessary to establish five or six associated factories working in various parts of India so that the waste product and bye-product of one of the units will become the main raw material of another unit and so on. These five or six associated factories working with a central head office in a place like Calcutta can do much more for the solving of unemployment problem amongst scientific workers in addition to helping the trade and commerce of the country. I am sure at least a couple of thousand science graduates can be absorbed in this. Apart from the formation of this company it is also necessary to request every zeminder, every agricultural farm, every garden owner, every forest officer, every trader, and every chamber of commerce to co-operate in having a single Indian organisation manned by Indians only so that competition and unnecessary price cutting could be eliminated. An organisation of this type can produce essential oils from almost all the materials available in India and use the same in part at least to re-manufacture aromatic chemicals as shown below :—

RAW MATERIALS FOR ESSENTIAL OILS AND AROMATIC CHEMICALS AVAILABLE IN INDIA.

1. GRASSES. *Essential Oils.* *Aromatic chemicals.*

- | | |
|-----------------------|---|
| 1. Lemon grass oil | 1. Citral
2. Ionone
3. Geraniol
4. Linalol etc. |
| 2. Citronella oil ... | 1. Citronellol
2. Citronellal
3. Hydroxy-citronellal
4. Geraniol
5. Rhodinol
6. Linalol etc. |
| 3. Geranium oil ... | 1. Geraniol
2. Geranyl acetate
3. Rhodinol
4. Citronellal etc. |
| 4. Khus Khus oil | 1. Vetivenol
2. Resinoid vetiver etc. |
| 5. Palmarosa oil ... | 1. Geraniol
2. Farnesol etc. |
| 6. Ginger grass oil | 1. Geraniol
2. Perilla alcohol etc. |

2. ROOTS & RHIZOMES.

- | <i>Essential Oils.</i> | <i>Aromatic chemicals.</i> |
|------------------------|--|
| 1. Ginger oil ... | 1. Cineol
2. Decyl aldehyde
3. Linalol
4. Gingerol etc. |
| 2. Sandal oil ... | Santalol etc. |
| 3. Valerian oil ... | 1. Bornyl acetate
2. Bornyl isovalerate etc. |
| 4. Turmeric oil | |
| 5. Costos root oil | |
| 6. Sumbul root oil | |
| 7. Onion oil | |
| 8. Garlic oil | |
| 9. Calamus oil | |

3. LEAVES.

- | | |
|--------------------------|-------------------------------|
| 1. Eucalyptus oil | Cineol etc. |
| 2. Gaultheria oil | Methyl salicylate etc. |
| 3. Petitgrain oil | |
| 4. Cinnamon leaf oil ... | Cinnamic aldehyde etc |
| 5. Verbena oil ... | 1. Citral
2. Geraniol etc. |
| 6. Clove oil ... | Eugenol etc. |

4. SEEDS.

- | | |
|-------------------|---------------------------------------|
| 1. Ajwan oil ... | 1. Thymol
2. Thymene etc. |
| 2. Anise oil ... | 1. Anisic Aldehyde
2. Anethol etc. |
| 3. Caraway oil .. | Carvone etc. |
| 4. Cardamom oil | |

- | | |
|----------------------|---|
| 5. Coriander oil ... | 1. Linalol
2. Linalyl Acetate etc. |
| 6. Cumin oil ... | 1. Cumin Alcohol
2. Cumin Aldehyde
3. Cymene etc. |
| 7. Dill oil ... | Anethol etc. |

5. FLOWERS.

- | |
|-----------------------|
| 1. Rose oil |
| 2. Jasmine oil |
| 3. Lotus oil |
| 4. Bakul oil |
| 5. Champak oil |
| 6. Tuberose oil |
| 7. Orange flowers oil |
| 8. Kewra oil |

6 FRUITS.

<i>Essential Oils.</i>	<i>Aromatic chemicals.</i>
1. Orange oil ...	1. Limonene 2. Citral 3. Nonyl alcohol 4. Decyl alcohol etc.
2. Lemon oil ...	1. Limonene 2. Citral etc.
3. Mandarin oil	
4. Cubeb oil ...	1. Cadinene 2. Cubeb-camphor etc.
5. Fennel oil ...	1. Anethole 2. Fenchone etc.
6. Grape fruit oil	1. Linalol 2. Citral 3. Geraniol etc.
7. Juniper Berries oil ...	1. Sabinene 2. Terpeneol etc.
8. Linaloe oil ...	1. Linalol 2. Linalyl acetate etc.
9. Pepper oil ...	1. Caryophyllene 2. Geraniol 3. Cuminic aldehyde etc.
10. Nutmeg oil ...	Myristicin etc.

7. HERBS.

1. Basil oil ...	1. Methyl cinnamate 2. Eugenol 3. Thymol 4. Camphor 5. Cineol 6. Linalol etc.
2. Spearmint oil ...	1. Carvone 2. Dihydrocarvol acetate

8 WOOD.

1. Cedar wood oil	1. Cedrol 2. Cedar-camphor etc.
2. Camphor oil ...	1. Camphor 2. Saffrol etc.
3. Junper wood oil	1. Sabinene 2. Terpeneol etc.
4. Linaloe wood oil	1. Linalol 2. Linalyl acetate etc.
5. Sandal wood oil	1. Santalol 2. Santalyl acetates etc.
6. Turpentine oil	Terpeneol etc.

9. GUMS.

<i>Essential Oils.</i>	<i>Aromatic chemicals.</i>
1. Copaiba oil	
2. Olibanum oil	
3. Opoponax oil	
4. Black dammar oil	
10. MISCELLANEOUS	1. Oakmoss

During the last post-War period 1919 to 1923, a large number of firms sprang up and closed down also as rapidly as they were formed due to their imperfect planning. If we take a stock of the companies organised it will be apparent that a large number of them depended on essential oils for finishing their products. The past twenty-five years have brought into existence soap factories, pharmaceutical works, confectionery works, tobacco and cigarettes factories, distilleries for manufacture of alcohols and wines, aerated water factories, companies for the manufacture of perfumes, factories for the manufacture of face creams, toothpaste and other articles for personal use, factories for the manufacture of insecticides and deodorants, works for the manufacture of printing inks, tanneries for leather treatment and many others. Each and every one of these trades requires essential oils for the manufacture of their finished products.

Let us now consider for a moment the present centres of our essential oil manufacturers and how they are going about their business. The list is not however exhaustive.

(a) *Kanauj*.—This place is about fifty miles from Cawnpore and is well known from time immemorial for manufacture of perfumes of all sorts. At the present moment the place is no better than a big village and the number of houses working on cottage industry basis comes to about thirty. Many of these old houses are still continuing their old process for special *attars*. Only one party has introduced steam distillation plant and are producing sandal wood oil on up-to-date lines. The other people are manufacturing rose water and rose attar, Bela oil and Jasmine attar. These people have their own arrangements at Bharatpur for distillation of Khus Khus oil, at Barwana for utilising rose gardens of that place, at Chatrapur-Berhampur (Ganjam) for distillation of Kewra oil and Kewra water. The methods employed are still crude and with slight modification of the apparatus it is quite possible to increase the yield and better odour. The main difficulty with these people is their indiscriminate use of sandal wood oil in each and every product. The result is unfortunately not very happy. There is no fixed

standard upon which you can rely upon the products manufactured.

(b) *Cawnpore*.—Most of the essential oil firms have their head offices in Kanauj. There are two or three firms who are specialising in tobacco curing and scenting.

(c) *Lucknow*.—There is only one firm of an all India reputation who is manufacturing Hena perfume. The others are mostly tobacco curers and perfumers.

(d) *Benares*.—Here also the tendency for tobacco curing and perfuming is very great.

(e) *Gazipur*.—This place is about thirty miles from Benares and was once famous for its rose gardens and rose water. Unfortunately much of its importance is now gone.

(f) *Bharatpur*.—Plenty of Khus Khus grass grows round about this place. The distillation takes place in the months of November, December, January and February. The methods employed lead to much wastage and can be improved by slight modification. The total quantity of oil can be brought up to about fifteen thousand pounds and can effectively check importation of this product from Reunion and other places.

(g) *Barawana*.—This is quite close to Hathras junction and is more or less a granary for rose flowers. Although people from Kanauj and other places have their own establishment for distillation of rose water, and *attar*, both the quality and the quantity could be improved by introducing vacuum distillation plants. We could in a period like this, when foreign importation of rose perfumes are entirely cut off, help this industry to a very great extent.

(h) *Chatrapur*.—Berhampur (Ganjam). This place is famous for abundance of Kewra flowers and is supplying practically the whole of Northern Indian market. Here also modern methods of distillation will improve the yield.

(i) *Kuppan*.—This place is about fifty miles from Bangalore. They occasionally distil also Patchouli oil and other oils according to circumstances. Both the factories have up-to-date steam distillation plants. Their methods may be called a fairly decent improvement over the crude methods employed by other Indian distillers.

(j) *Mysore*.—The world-renowned Sandal Wood Oil Factory already referred to above, is situated here. The whole organisation of the Mysore Government Forest Department co-operating with the authorities of the Sandal Wood Oil Factory has contributed much to the success of this concern. It is

also a matter of gratification to note the Railway Department is adding their share of co-operation in giving all the facilities for transit of goods both finished and unfinished.

About seven miles from Mysore a private gentleman having his training at the Victoria Technical Institute, Bombay is the owner and proprietor of a large estate cultivating Davana herb and coriander plants. Both these oils are somewhat costly and the sale is therefore outside India. This is the best example of a qualified private individual doing business in the right spirit.

(k) *Mettur*.—This place is well known in India for its Dam across the river Cauvery. It is about forty miles from Salem and also Erode. A private gentleman has started a Sandal Wood Oil Factory a couple of years back on up-to-date lines. He expects in the near future to be in a position to utilise all the surplus Sandal Wood available in South India. He claims the quality of the oil to be as good as that of Kuppum Sandal Wood Oil.

(l) There are several places in South India as well as Bombay Presidency where a very large quantity of Agarbatis are manufactured on a cottage industry basis. The total volume of business runs to about ten lakhs of rupees spread throughout the whole of India.

(m) There are several places in Central Provinces, Berar, Central India and portions of Bombay Presidency where Palmarosa oil is being distilled in the usual indigenous way. There is no single factory worth mentioning wherein this important product is treated in a way which it deserves. A number of small distillation plants and uncertain quality of the oil go unfortunately to make this business a speculator's job.

(n) *Utran (East Khandesh)*.—Arrangements are made here for the distillation of the Oil of Limes. The major portion of this oil is being exported.

(o) *Bombay*.—Recently a sandal wood oil factory has been started by a Parsi gentleman on a small scale. The venture may be good in its own way. For want of a proper understanding with the various sandal wood oil factories existing in India the rate of the sandal wood oil has been unfortunately made to fluctuate in an uneconomic manner.

(p) *Talgunni Estate (Bangalore District)*.—For the last few years linaloe oil is being manufactured on a small scale. There is plenty of scope for enlarging the factory and supplying the needs of the whole of India in Linalol group of aromatics. At present the distillation is somewhat irregular and the quantity of oil is also not sufficient.

(q) There are many places in Travancore and Madras Presidency where lemon grass oil is distilled on the usual Indian methods. The quantity produced is quite large and it would pay to rectify the oil and get several aromatic chemicals from this important oil.

The volume of business in rose, Bela oil, Jasmine, Khus and Kewra will run to more than twenty lakhs of rupees and can be raised if improved methods are employed to about fifty lakhs of rupees. The improvement can also go to stop the importation of synthetic floral perfumes to a very great extent. Besides the above mentioned flowers we have also Champaka flowers, Bakul flowers, Tuberose flowers which could be conveniently worked up but so far nothing is being done.

By exporting palmarosa oil, lemon grass oil and ginger grass oil we are practically throwing away precious material for a nominal value. We can produce geraniol and all its esters from palmarosa oil, citral, ionone and other aromatics from lemon grass oil. The amount involved in palmarosa oil, ginger grass oil, lemon grass oil and local citronella oil runs to about fifty lakhs of rupees.

Citrous fruit oils—We have plenty of oranges and lemons of various sorts and can conveniently produce lemon and orange oils, citric acid, lemon and orange marmalades jellies and jams. The extent of business carried on at Nagpur (Central Provinces), Coorg (South India), Sylhet (Assam) and Darjeeling (Bengal) and Lyallpur (Punjab) is about one and a half crores of rupees. But we are satisfied with only eating the fruits and at the same time we are importing plenty of citric acid and other lemon and orange products from abroad.

Sandal wood oil—Mysore State and other private factories account for a volume of business varying from thirty to fifty lakhs of rupees. It is a pity to note that some of our traders are importing Australian and West Indian oils on the score of cheapness only. The value of this import is not likely to be less than a couple of lakhs of rupees.

Turpentine oil—There are two or three factories in India. The biggest is the one at Bareilly (U. P.). The smallest one is the one located in Calcutta. Turpentine oil industry is a very important line of business in paints and colours. We require at least a couple or more to supply the needs of India in full. Besides, turpentine oil is the starting material for a number of aromatic chemicals of a very great industrial importance. For instance, terpineol is used in perfumery, soap and other trades as a solvent. A second series of aromatic chemicals from this oil is thymol and menthol. At present there is no move whatsoever in this direction.

Eucalyptus oil.—At the present moment Nilgiris (South India) is the biggest supplier of this important oil. The distillations are being carried on a small scale. It is a pity that there is no single firm who can give oil of guaranteed quality. A large quantity of Australian oil is being imported.

There are many undeveloped lines wherein business in essential oil could be profitably undertaken. There is the *common Tulsi* which is known by everybody. Eight or ten different varieties are available. About ten lakhs of rupees worth of eugenol, methyl cinnamate, camphor oil, linalol and linalyl acetate could be manufactured. We have enough land lying waste and also enough people sitting idle. There should be no difficulty in growing not only Tulsi but also other small plants of economic importance.

Essential oils from seeds—We can grow enough coriander, caraway, anise, ajowan, etc., by following an economic policy. It is possible to produce thymol which we are at present importing in huge quantities. In Russia about seventy thousand acres of land are devoted to coriander plantations only. The coriander oil yields the following aromatic chemicals, viz., Decyl aldehyde, Linalol, Linalyl acetate, synthetic Lemon oil which are all useful for perfumery and for soap trade. We have in South India clove, cardamon, pepper and other spices which require development. We are being flooded from Zanzibar and other places with natural cloves, clove oils from buds, clove oils from stalks and also with exhausted cloves for purposes of adulteration.

We are selling ginger, turmeric and other useful materials without the slightest preliminary treatment. We can conveniently extract oil and produce oleo-resin ginger and sell the finished product at a decent price.

If we take into account what other countries are producing we find wherever climatic conditions and finance permits, suitable undertakings have sprung up to work out and take full advantage of the natural resources of the place. Each of these new ventures in addition to the old ones tries to flood the Indian markets with essential oils and aromatic chemicals. We may, therefore, in the near future have to face a serious dumping campaign unless our present Government ban once for all such importation.

The Essential Oil Industry needs very badly a good laboratory to test the various indigenous products and also to teach and train a band of science graduates for future absorption in the industry. At the present moment the Indian Institute of Science, Bangalore, the Benares Hindu University, the Forest

Research Institute, Dehra Dun are playing their legitimate part in this connection.

The credit of carrying out really scientific methods and processes in essential oil factories goes to the Indian Institute of Science, Bangalore. The most notable work of this great institution is the opening of the Mysore Government Sandal Wood Oil Factory, Bhadravati Iron Works and many other Mysore State concerns. The Institute has been responsible in giving encouragement to a large number of workers under able professors to carry on research work in this line. Dr Watson and Dr Sudborough have by their painstaking efforts trained a large number of Indian students in carrying out researches in this line. The Institute, being an all-India organisation attracts students and workers from all parts of India and has been the forerunner of research work in essential oil bearing plants in various institutions in India. The publications of the Institute will show the amount of spade work that has already been carried out there. In addition to providing for researches in pure chemistry it has also other departments which have contributed to the success of its being truly called the Industrial Laboratory.

Next in order of importance comes the Benares Hindu University. During the last 10 years it has trained a number of students taking essential oils as their special subject for degree course. A number of such trained students have already started independent concerns of their own and also helped to fill up a long-left gap in various concerns requiring the need of essential oil chemists. It is to the credit of the Benares Hindu University that they have been able to enlist the sympathy of an Indian capitalist in starting an essential oil factory, viz., the Hindusthan Aromatics Company, Naini, Allahabad.

Next comes the Forest Research Institute at Dehra Dun. Though its activities are mainly towards forest conservation and utilisation of forest materials, a number of workers have carried out researches on essential oil bearing roots, woods, leaves, seeds, fruits, etc., in the past. The appointment of Forest Utilisation Officers is a very desirable move and any specific matter referred to them is being attended to with as much care as possible.

Last comes the Victoria Technical Institute, Bombay. Their technical courses have been of a very practical nature. I am glad to note that one of the students is actually running an estate of about one hundred acres devoted for the cultivation of essential oil bearing herbs—*Davana*—in Mysore.

There are a large number of Agricultural Colleges in India but unfortunately the contributions of research work on essential oil bearing problems have been meagre. Let us hope that they will in the near future include a course on essential oil yielding plants, particularly in such provinces as are likely to be very conducive to growth of essential oil plants and herbs as alternate crops or on stretches of land going to waste.

Among the foreign institutions who have taken considerable interest in Indian raw materials may be mentioned the Imperial Institute of London, the Koloniaal Institute at Amsterdam, Department of Commerce, Washington, various Chambers of Commerce and universities of the respective countries. The Imperial Institute of London as is evident from its publication have acted as a very good checking station for some of the results obtained in institutions in India. The present day sources of authoritative information on recent developments in essential oil industry is through the journals of the various countries in the world. Great Britain has four to its credit. (1) *Perfumery & Essential Oil Record*, (2) *Soap, Perfumes and Cosmetics*, (3) *Chemist & Druggist* and (4) *Manufacturing Perfumer*. A major portion of the articles relate to some problem or the other connected with use of essential oils and aromatics. France has got two or three of them, viz., (1) *Les Parfums de France*, (2) *La Parfumerie Moderne* and (3) *Bulletin* and later *Researches of Roure Bertrand Fils*. Germany has nearly half a dozen publications, viz., (1) *Schimmel & Co.'s* world famous annual reports, (2) *Riechstoff-Industrie und Kosmetik* etc. United States of America publish two or three of them, viz., (1) *American Perfumer*, (2) *Soap*, (3) *Oil, Paint & Drug Reporter*. Italy has *Rivista Italiana delle Essenze, dei Profumi e delle Piante Officinali*. Austria has *Ole, Fette, Wachse* published from Vienna. Japan too has a few of them. If the progress of any industry is an index to the scientific development of a country then surely we are the most backward as there is not a single journal in India devoted solely to this subject. Our sources of information for the time being will have to be mostly from foreign journals and periodicals.

We are not only backward in the matter of an essential oil journals but are also equally so in the method of collecting and codifying statistics in this line. The method adopted for collecting data are rather defective if not faulty. It is a pity that our Indian Chambers of Commerce with a fairly large number of members is mostly concerned with trade concessions rather than industrial development. It is the duty of every Chamber of Commerce to undertake collection of proper statistics in every branch of

trade for which the Chamber is intended. It would not be difficult for a Chamber of Commerce to employ suitable men exclusively for statistical work. They would be really doing immense service to their constituent members. If this is done a greater number of traders will also be happy to enroll themselves as members. This public sympathy of traders for Chambers of Commerce would certainly go a great way to make the present Government feel interested in them. At the present moment we are to depend upon the Customs authorities for what little information they choose to publish. Even there the Customs authorities are interested more in the collection of revenue rather than keep a proper statistical record. It is not unknown to any business man that whenever he gets a consignment of goods from a foreign country he has to fill in a custom manifest for purposes of duty before clearing the goods. Unfortunately the type of clearing Sirkars who usually fill up the manifest do so somewhat haphazardly. There is no remedy for preventing the entry of one and the same article either under the head "Medicine" or under the head "Essential oils" or under the head "Chemicals" or under the head "Drugs" or under the head "Perfumery" or under the head "Confectionary" or lastly under the head "Other sorts not specified". Hence statistics published by the Commercial Intelligence Department in the essential oil and perfumery line is open to a good deal of correction.

The following tables give the approximate annual figures for imports, for exports and also the figures for internal consumption in India. The figures have been compiled by taking into account transactions covering a period of fifteen years, i.e., from 1925 onwards.

From these tables one can judge for himself what quantities of essential oils and aromatics India can produce taking into account her vast extent of land, her vast varied climate, her vast population and lastly her vast capacity for internal use.

The tables on the next page taken from Messrs Schimmel & Co.'s Report of 1934 will be found interesting and instructive with reference to what has been said above.

Many of the Native States in India have been at considerable pains to develop their economic resources during the last forty years. Among the most progressive ones are Mysore, Travancore, Baroda, Gwalior, Hyderabad and others.

Mysore, under its able Dewan, Sir M. Visvesvaraya will be remembered with gratitude by the future generations of India for showing to them how under proper Government support the resources of India could be developed.

The other Native States can easily, if they so choose it, help in starting State or private factories in their own territories.*

ANNUAL IMPORTS.†

1. Essential Oils from grasses ...	Rs.	10,00,000
2. Essential " " leaves, stems and stalks ...	"	4,25,000
3. " " " seeds ...	"	3,42,500
4. " " " roots and bark ...	"	3,40,000
5. " " " fruits ...	"	5,69,000
6. " " " flowers ...	"	15,05,000
7. " " " wood ...	"	5,69,000
8. " " " resins and gums ...	"	20,76,000
9. Synthetic Essential Oils ...	"	58,15,000
10. Aromatic Chemicals ...	"	76,76,000
11. Flavouring Essences (Alcoholic and non-alcoholic) ...	"	20,00,000
12. Fruit Extracts and Essences ...	"	10,00,000
13. Essential Oil producing leaves ...	"	1,00,000
15. " " " seeds ...	"	6,72,000
16. " " " flowers & buds ...	"	40,00,000
Total ...	Rs.	2,83,39,500

ANNUAL EXPORTS.†

1. Essential Oils from grasses ...	Rs.	25,90,000
2. " " " wood ...	"	25,90,000
3. " " " producing seeds ...	"	1,15,65,000
4. " " " roots ...	"	51,00,000
5. " " " wood ...	"	?
6. " " " gums ...	"	?
7. " " " fruits ...	"	?
8. " " " bark ...	"	?
Total ‡	Rs.	2,17,55,000

INTERNAL CONSUMPTION.†

1. Essential Oils from grasses ...	Rs.	16,50,000
2. " " " leaves ...	"	15,89,000
3. " " " seeds ...	"	3,23,000
4. " " " roots & barks ...	"	11,70,000
5. " " " flowers ...	"	55,00,000
6. " " " woods ...	"	4,65,000
7. " " " fruits ...	"	4,39,000
8. " " " resins & gums ...	"	68,500
9. Synthetic Essential Oils ...	"	60,00,000
10. Aromatic Chemicals ...	"	80,00,000
11. Flavouring Essences ...	"	20,00,000
12. Fruit Extracts and Essences ...	"	10,00,000
Total §	Rs.	2,82,04,500

* The author acknowledges with gratitude the kind help rendered by the Essential Oil Exploratory Committee under B. S. I. R. and the authorities of the Royal Botanic Gardens at Sibpur in preparation of this discourse.

† There may be a few omissions here and there and also there may be some mistakes in numerical calculations. The author will be grateful if the mistakes are pointed out.

‡ There are many items for which figures are not yet available and hence the total is not what it should be.

§ These figures are probably much lower than actuals.

VOLATILE OILS WITH A TOTAL ANNUAL PRODUCTION FROM
1,000 to 10,000 Kg.

<i>Volatile oil.</i>	<i>Average annual production.</i>	<i>Origin.</i>
Ajowan oil ...	2 to 3 t	British India.
Bay oil ...	8 to 10 t	West Indies.
Calamus oil ...	1 to 2 t	Russia.
Caraway oil ...	(?)	Holland, America, United States, Germany, England.
Gingergrass oil ...	1.5 to 3 t	British India.
Orris root oil ...	1 to 2 t	France, Germany.
Linaloe oil, Mexican? ...	? (formerly 5 t)	Mexico.
Mandarin oil ...	5 t	Sicily, Calabria (5 t), Jamaica (limited quantity).
Myrtle oil ...	2 to 3 t	Spain (2 t), Italy (0.5 to 1 t).
Neroli oil ...	2 to 2.5 t	France (1.5 t), Algeria and Tunisia (0.2 to 0.5 t), Italy (0.25 to 0.4 t), Spain (0.1 to 0.2 t).
Niaouli oil ...	5 to 10 t	New Caledonia
Pimento leaf oil ...	3 to 5 t	West Indies.
Rue oil ...	2 t	Spain.
Rose oil ...	2.5 to 3.5 t	Bulgaria (2 to 3 t), Turkey (0.3 to 0.6 t), Italy (0.1 to 0.15 t).
Quendel oil ...	5 to 6 t (?)	Russia.

VOLATILE OILS WITH A TOTAL ANNUAL PRODUCTION FROM
10,000 to 50,000 Kg

<i>Volatile oil.</i>	<i>Average annual production.</i>	<i>Origin.</i>
Anise oil ...	20 to 25 t (?)	Russia.
Bitter Orange oil ...	25 t	Sicily and Calabria (20 t), Jamaica (5 t).
Cananga oil ...	10 to 15 t	Java.
Chenopodium oil ...	20 to 30 t	United States.
Coriander oil ...	30 to 35 t	Russia (30 t), Germany, United States, England, Hungary, Italy, Czechoslovakia (?).
Juniper berry oil ...	5 to 10 t	Czechoslovakia (5 to 10 t), Hungary, Yugoslavia (?) Germany, West Indies.
Lime oil ...	30 to 40 t	
Mawah oil (fr. Pelargonium graveolens) ...	12 t	British-East Africa and Belgian Congo.
Pennyroyal oil ...	15 to 20 t	Spain (10 t), United States (5 to 10 t), Algeria (?).
Origanum oil ...	30 to 40 t	Spain (25 to 30 t), Italy (5 to 10 t), France (?), Palestine (?).
Palmarosa oil ...	30 to 40 t	British India.
Patchouli oil ...	18 to 23 t	British Malay States and Straits Settlements (15 to 20 t), Seychelles (3 to 5 t).
Sassafras oil ...	40 to 50 t	United States.
Vetiver oil ...	12 to 15 t	Reunion (6 to 15 t), Java (5 to 10 t).
Wintergreen oil ...	35 t	United States.
Thyme oil ...	25 to 30 t	Spain (25 t), France (0.5 to 1 t), Italy (?), Palestine (?).
Ylang-Ylang oil ...	17 to 24 t	Manila (0.7 to 0.8 t), Madagascar (15 to 20 t), Reunion (2 to 3 t).

VOLATILE OILS WITH A TOTAL ANNUAL PRODUCTION FROM
50 TO 100 TONS.

<i>Volatile oil.</i>	<i>Average annual production.</i>	<i>Origin.</i>
Cinnamon leaf oil ...	90 to 100 t	Ceylon (50 to 60 t), Seychelles (40 t).
Cajepout oil ...	95 to 100 t	Dutch Indies (90 to 100 t), Annam (5 t).
Petitgrain oil ...	82 to 92 t	Paraguay (80 to 90 t), France (1 to 2 t), Italy (0.5 to 1 t), Algeria (0.25 to 0.5 t).
Schia oil ...	30 to 100 t	Japan.

VOLATILE OILS WITH AN ANNUAL PRODUCTION OVER 100 TONS.

	Average annual production.	Origin.
Spike oil ...	150 to 175 t	Spain (125 to 150 t), France (25 t), Italy (?), Dalmatia (?).
Staranise oil ...	400 to 500 t	Tongkong (100 t), China (300 to 400 t).
Bergamot oil ...	170 t	Calabria (170 t), United States (experimental), Guinea (experimental).
Linaloe oil ...	100 t	Brazil (nearly 100 t), Guaiana (15 to 20 t).
Cedarwood oil ...	100 to 105 t	United States (100 t), Morocco (4 to 5 t), Italy (0.1 t).
Lemon oil ...	700 to 800 t	Sicily and Calabria (700 t), United States (100 to 125 t), Martinique (0.6 t), Madagascar (0.1 t), Guinea (experimental).
Citronella oil ...	1,500 to 1,700 t	Ceylon (500 to 700 t), Java (1,000 to 1,200 t), India (5 to 10 t).
Cassia oil and cinnamon bark oil ...	100 to 200 t	China (100 to 200 t, Cassia oil) Java (2 to 5 t), Ceylon (5 to 6 t).
Camphor oil ...	4,200 to 4,500 t	Japan (300 t), Formosa (1,200 to 1,500 t).
Eucalyptus oil ...	500 t	Australia (400 t), Spain (80 to 100 t), India (?), Italy (0.25 to 0.5 t).
Geranium oil ...	100 to 125 t	Reunion (80 t), North Africa (20 to 30 t), Grasse (2 to 3 t), Spain (1 to 2 t), Russia (3 to 5 t).
Clove oil ...	(?)	Madagascar (?), European countries.
Lavender oil ...	95 to 115 t	France (80 to 100 t), Spain (2 to 3 t), Italy (10 t), England (?).
Lemongrass oil ...	190 to 320 t	India (150 to 270 t), Madagascar (40 to 50 t), Martinique (0.4 to 0.5 t).
Peppermint oil ...	725 to 850 t	United States (350 to 400 t), Japan (250 to 300 t), Italy (100 to 120 t), Russia (10 to 20 t), France (20 to 30 t), England (5 to 10 t).
Pine and Spruce needle oil ...	(?)	Tyrol, Czechoslovakia, Russia, Sweden, Switzerland (?).
Sweet orange oil ...	200 to 250 t	Sicily and Calabria (fell from 100 to 25 t), Guinea (100 to 120 t), Jamaica (30 t), California (25 t), Spain (10 to 15 t), South Africa (10 to 15 t), Brazil (0.5 t).
Rosmary oil ...	100 to 125 t	Spain (70 to 100 t), Yugoslavia (10 to 15 t), France (5 to 10 t), Italy (1.5 t).
Sandalwood oil East Indian ...	70 to 80 t	Mysore (70 to 80 t), European countries (?).
Sandalwood oil, Australian ...	25 to 30 t	Australia (25 to 30 t).

DIET MAKES PLATINUM FOXES

The platinum foxes imported from a small farm in Norway last year made a sensation. Only a certain strain could produce fur of the platinum variety. Dr Agnes Fay of the University of California finds that simply by depriving ordinary silver foxes of one of the "B" group of vitamins she can obtain the platinum kind of fur every time. This discovery was made during experiments to determine the possible connection between lack of antigray vitamin and gray hair and premature old age in human beings.

Unfortunately, Dr Fay's artificially platinized foxes do not produce furs so durable as the Norwegian variety. She thinks the difficulty can be overcome by proper control of diet.

—The New York Times.

MEDICINE & PUBLIC HEALTH

American Public Health Programme

IN a paper read before the Western Branch of American Public Health Association in June, 1940 and published in the *American Journal of Public Health*, Sept, 1940, Drs. Armstrong and Shepherd, who belong to the well-known Metropolitan Insurance Company, have made some valuable suggestions for a co-ordinated health programme for their country. Within limitations, they will be found to be useful for those who wish to see the public health policy of India brought up to date. The proposals detailed below fit in with the ideals of democracy and involve a minimum degree of compulsion, politicalization and the kind of collectivism (of which compulsory sickness insurance is an example) that in so many countries has been concomitant with dictatorship. The chief emphasis has been laid on prevention and the participation of the medical profession and voluntary co-operative agencies.

A thorough-going public health and preventive medical programme, including education as well as practical services should receive first consideration. It will aim to decrease, so far as is within our power, the burden of preventible illness. Any degree of success here will cut down the necessity for the more expensive diagnostic and therapeutic facilities, all of which must be paid for, whether by fees, taxes, philanthropy, or insurance. Experience shows that prevention is soon lost sight of when the community becomes distracted with fund raising schemes to pay for the treatment of illness. Though unspectacular and often intangible, prevention is a wise investment. It requires, however, continuous exploitation and promotion, since the more successful it is, the less spectacular it becomes; and the less likely, therefore, to receive financial support. Nothing stimulates the purchase of fire engines like a bad fire, and nothing increases the health department budget like a bad epidemic.

Next, a high standard of private medical services must be maintained and fostered. This includes

continued and increased funds for the best of medical training, both under-graduate and post-graduate. It also includes ample funds for the research which is essential to the advance of medicine. It involves adequate compensation for the private practising physician. Even though largely supported by the fraction of the population comprising the upper economic levels, private practice, medical education, and research are the germinal fields from which spring much of medicine's growth and progress.

Voluntary and State Efforts in Health Programme

To achieve success in health programme people should be encouraged to co-operate by prepayment plans to cover hospital costs, medical costs, cash indemnity against wage loss, and combinations of the three. Experiments should also include cash benefits to cover hospital and medical costs, as well as service benefits with no cash. The structure of these experimental plans should be adapted to local needs, traditions, and choices. Sponsorship may come from any responsible organized groups, such as industries, unions, farm granges, mutual benefit societies, or from medical organizations. In all cases, medical advisory leadership is essential, including proper attention to prevention. As rapidly as they prove successful, these experiments should be expanded to include as large a fraction of the employed population and its dependents as can pay its way into such a programme. The more people included in such plans, the fewer will require other types of plans which are less satisfactory because they offer less freedom. Such voluntary prepayment plans might well be encouraged on a commercial group insurance basis with the well established insurance companies, in which the employer participates in the cost. Group sickness insurance with a reliable company, provided by the employer and employee jointly through pay roll deductions, should be an important link in personnel relations, and might lift many employees out of the class of "medical indigents".

Combinations for Special Population Units

Full development of voluntary prepayment plans may still leave certain non-indigent groups uncared for, such as scattered agricultural groups, small shopkeepers, and self-employed individuals. Health and medical needs for these units can probably be met best by a combination of adequate public health services, a better implemented private medical practice, and perhaps, in some areas, hospitals and other facilities supported by local funds or by Federal or State subsidy. Such subsidies should facilitate but not regiment the practice of medicine, and should vary according to local needs and choices, all the way from providing physicians with free biologicals, essential laboratory services, and access to a hospital which is publicly supported, to a minimum fixed salary or income in isolated instances.

Hospital facilities and medical care at public expense should in the meantime be continued and enhanced, with medical relief under the supervision of the medical profession. Enhancement should be along the lines of providing competent medical and nursing care where practicable in outpatient clinics and in homes, and should include adequate compensation for physicians rendering care to indigents, on a locally determined fee rather than a salary basis. State or local subsidy will often be essential for areas overwhelmed by indigency, but even here use should be made, as far as possible, of the freely chosen private practitioner, or of such medical personnel as may have been co-ordinated under the auspices of private medical or voluntary prepayment schemes.

Birth Control Programme Sponsored by the State

FIELD Nurse Frances R. Pratt, writing in September, 1940 Number of the *American Journal of Public Health*, gives us some information about the first birth control programme initiated by any State department of health in U. S. A. The objectives of this programme were three-fold:

1. To reduce the high infant mortality rate and the loss of mothers' lives.
2. To curb the high birth rate among dependent families and create an awareness of the importance of proper spacing of all future children of the State as the prerequisite for healthful and happy family life.
3. To endeavour to increase the birth rate among the physically fit, and the financially and intellectually competent.

Several social service organisations did valuable ground work since 1932 by educating the population to seek a better medical health programme for indigent mothers who supported the idea of passing resolutions on the establishment of birth control centres on the subject at various centres. Two and a half years ago the State Board of Health quietly and unostentatiously devised plans whereby indigent mothers, overburdened by too frequent pregnancies, and in most cases suffering from disabling diseases, were given contraceptive advice through the country health officials. The health department realised that something definite should be done to control the birth rate among the diseased of the indigent class, and at the same time bring relief and better health to a large group of indigent helpless women whose pleadings for birth control information had long gone unheeded, especially in view of the fact that there were no longer Federal or State legal restrictions against giving this information. The indications for birth control were more medical than anything else and no case was advised unless a private physician or the medical society or the health officer so advised, as the object was to prevent legitimately further births among women who are had maternal risks, both for themselves and for their babies.

Clinics have been established and placed in charge of specially trained public health nurses. Patients are received at the centres for a number of reasons—enough children already, child sparing desired, and for any justifiable medical indication. In some centres patients are referred to hospital clinics, in others to family physicians, private physicians, health department clinics, or they are instructed through home visits by public health nurses, the last being more applicable to rural districts.

The State programme was initiated in March, 1937, when there were only two clinics. At the end of the second year, there were 62 centres in 60 counties, which has instructed over 2000 patients. An indication that the general programme is producing results is that the vital statistics of the State during the first 6 months of 1939 compared with the first 6 months of 1938 showed a decrease both in infant and maternal deaths. The decrease has affected both birth and death rates.

Arrangements have been made with the Institute for Research at the University of North Carolina to make a careful study of the case records kept by the health departments to determine the effectiveness of the different methods employed and the success of the general programme.

Substitution of Organs by Transplantation

F. KANDIBA

At the last International Congress of Physiologists in Moscow, the severed head of a dog, which went on living without the rest of its body, was demonstrated. Glass jars substituted the trunk, while an artificial heart supplied liquid from the substances in its arteries through tubes. The spectator could see for himself that the head retained the reflexes of a living dog: it moved its eyes, pricked its ears, twitched its nose, and dribbled.

The members of the Congress stood long before this head, for it marked a new stage† in science, a step forward to the marvellous land of the future, when doctors and physiologists will have learned to preserve the life of the organs of a living body separately, and to transplant them if necessary into other living bodies, for the renewal of their health and faculties.

The solution of this problem has been the object of research of thousands over a long period of time. For what could be more interesting than the prospect of substituting a healthy organ for one which has become diseased or deformed, and cannot be cured?

Up till quite lately operations of this sort have existed only in the dreams of scientists, or the pages of fantastic novels where gifted surgeons modelled living organisms as if they were sculptors making clay figures. And yet not long ago the successful transfusion of blood appeared just as fantastic, and now it is carried out in any big modern clinic, and no surgeon could do without it either in war or in peace.

The transplantation of tissue, which began with the substitution of missing pieces of bone, sinews, gristle, etc., and was subsequently fairly widely practised in the form of the transplantation of glands of

internal secretion, has now become an everyday phenomenon.

Many surgeons, notably the well-known Professor Bogoraz, of Rostov, now transplant the hypophysis of corpses to persons, defective owing to inadequate functioning of this gland, who begin to grow and attain puberty. The no-less famous Academician Filatov, of Odessa, whose speciality is ophthalmology, transfers the cornea of corpses to the blind, restoring to them their sight. By the transplantation of the skin taken from corpses Academician Filatov cures lupus and abscesses of all sorts, formerly considered incurable.

Innumerable examples of this sort might be cited. But even they do not presuppose the possibility of substituting diseased organs by those transferred from another person. From the point of view of modern medicine the chief significance of the operation of transferring tissue lies not merely in the fact that the transplanted tissues become living and in itself compensates for that which was lacking in the patient; but the significant fact is that these tissues are absorbed, and disappear,* thereby aiding the diseased organism to cope with its disease; the by-products thrown off by the transplanted tissue stimulate and enhance the faculties of the corresponding organs in the patient. Thus, the transplanted bone is absorbed, but a new, strong bone is formed in its place. Transplanted glands are absorbed and disappear entirely, but during the process of absorption, the corresponding glands of the patient formerly defective or subnormal become active and begin intensive work. The transplanted tissue only continues its lasting vitality, when transferred from one part to another of the same person or animal.

And yet every effort to transfer a whole organ from one person to another has so far ended in failure. Up till quite recently even the operation of transferr-

† The invention by Carrel and Lindbergh at the Rockefeller Institute for Medical Research of a 'Life Chamber' consisting of an artificial body of heart, lungs and blood-stream enabled scientists for the first time to keep these organs functioning and even growing for a long period outside the body. These authors have since published a book on the Culture of Organs which contains many interesting observations on the survival of organs outside the body. The possibility of the preservation of the life of an organ independently of the body as a whole was established long ago when it was pointed out that the heart of a boy, dead of pneumonia, could be revived in all its parts 20 days after death and interment (L. Hill—*Further Advances in Physiology*, 1930, p. 55)—Ed S & C

* Steinach, Sand, Lipschutz and Voronoff, however, give a different version. The testicular grafts in the male, if examined some months after re-implantation, show great hypertrophy of interstitial tissue but complete absence of spermatogenesis. In such series of experiments, the senile testicles of the host are rejuvenated on account of the general rejuvenation of the body caused by the hypertrophy of the interstitial tissue (vide Voronoff—*Greife des glandes endocrines*, 1930)—Ed S & C

ing the extremities from one mammal to another failed. The transplanted organs quickly died off, despite the fact that all blood-vessels and nerves were joined with an exactitude hitherto unknown to



FIG. 1.

Scheme of the transplantation of a paw from one rat to another.

survive. The growth and absorption of transplanted organs took place not only in cases of non-coincidence of blood-groups of the two organisms, but even when they "coincided." This fact was explained by the differing protein-contents of organisms.

The first to demonstrate that this view was mistaken was the American Schwind. He sewed up young rats in pairs, and then transplanted from one to the other their paws and tails in the same way that a toe is transferred from the foot to the hand of the same person. The transplanted extremity remained joined to its former owner by a tiny limb formed of skin, muscles and blood-vessels. The blood circulated through this limb until the extremity had begun to live in its new place. The limb was then severed, and the rat remained the sole owner of the new paw, or tail. Thus for the first time rats with five paws or two tails were seen. These rats went on living, and enjoying fair health, despite their strange appearance.

The Moscow Institute of Cytology, Histology and Embryology under the U. S. S. R. Academy of Science, is also working in the sphere of the transplantation of tissue and Dr. A. G. Lapchinsky, a member of its scientific staff, has, in addition to successful repetitions of Schwind's experiment, gone still farther.

Dr Lapchinsky has made experiments on the transplantation of tissue with rats, cats, and dogs, and achieved interesting results. The work of the surgeon here was of the utmost complexity and skill. He transferred the back paw of one young rat to another,

joining bones, sewing up muscles and nerves, and leaving a limb of skin and muscle for temporary blood-supply of the transferred paw. Thus the proper supply of oxygen and nourishment of the severed organ was ensured till the time when connections of the blood-vessels between itself and its new owner should be established. A few days after the operation the connecting limb was cautiously squeezed for ten minutes, twice a day, in order as soon as possible to isolate it from the circulation of its former owner. Then this limb, connecting one rat with the other, was severed, and one rat remained with two left back paws, the other, with one right

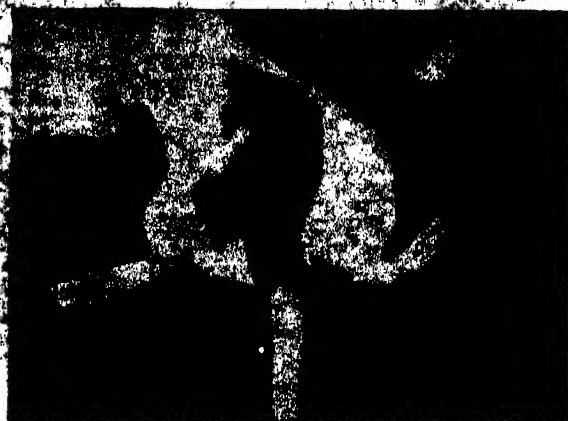


FIG. 2.

A rat whose both hind paws are left paws. The paw at left has been transplanted from another rat. (View from behind).

About a month after the transplantation, rats thus treated had begun to use the transferred paw. And then all traces of the operation began to disappear. The rats began to jump about, were able to scratch behind the ears with the transferred paw and squealed with pain if the paw was pricked. Thus, not merely the activity, but even the sensitivity of the transplanted extremity had been restored. Moreover, it grew and developed, and five and a half months after the transplantation had attained normal circulation and sensitivity. From the tiny paw of a newborn rat it had become the full-sized paw of an adult rat. It was not absorbed, and of course there could be no question of the substitution of the transferred organ by the tissue of the animal to which it was transferred. Animals so treated have been living in the laboratory upwards of one and half years.

In the opinion of many scientists the success of the transplantation in this instance may be ascribed to the fact that the transferred organ was assured correct supply of oxygen and nourishment of the cells from the very beginning. It is highly probable

that the failure of previous transplantations was due to inadequate observation of these conditions. It is significant that operations such as the transplantation of the cornea and the transfusion of blood, not demanding any special blood-supply have been so far the most successful.

Dr Lapchinsky considers that, since the transplantation of organs has been proved possible with rats, there are no grounds for supposing it to be theoretically impossible with other mammals, even with human beings.

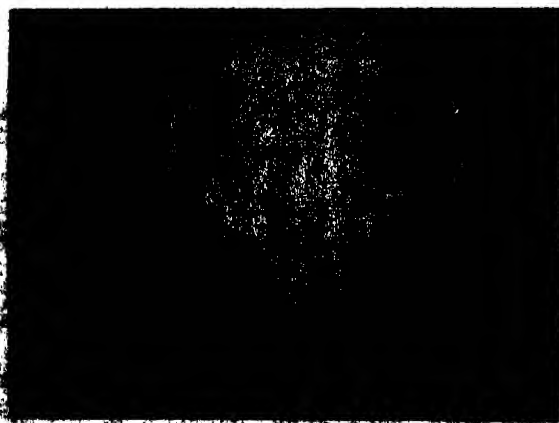


FIG. 3.

A rat whose both hind paws and left paws. The paw at left has been transplanted from another rat. (Röntgen ray photography).

Another, no less interesting series of experiments carried out by Dr Lapchinsky and Dr Malinovsky, another member of the scientific staff of the same institute, confirms this belief. This time the transplantation applies to teeth, and was done on rats and dogs.

At first the transplantation was applied to the hip-bone, where teeth cannot grow naturally. In this way, in the case of a successful operation, there could be no doubt as to the origin of the newly-formed tooth. The embryonic, and not the formed tooth was used, as being more susceptible to growth and showing greater adaptability to new conditions than hardened tissue.

Embryonic teeth were taken from new-born rats. Then the leg of a grown rat was incised, the hip-bone drilled, and the embryo-teeth transplanted into the marrow cavities after which the wound was sewn up. Two months later a slight protuberance could be felt on the surface of the bone, and in another few months a normal tooth appeared on the area treated.

Similar experiments were made on dogs which, as regards the conditions for transference of tissue, are much nearer to human beings than rats. These experiments were still more successful.

The embryo teeth of a puppy which died accidentally at twenty days, were transferred to the hip-bone of a dog, the day after the puppy's death. In a month protuberances could distinctly be felt on the bone, and a little later a normal dog's tooth developed. A Röntgen-ray photograph showed that, in addition to the visible parts of the tooth (the crown and neck) two normal fangs had grown inside the bone.



FIG. 4.

Tooth developed in the hip-bone of a dog.

The experiments drew the following conclusion from this fact: If the transplanted embryo teeth developed in the hip-bone, they would do so still better in the jaw. This conclusion was confirmed in the most convincing manner. Embryo teeth from a puppy, transferred to the jaw of a grown dog, developed in about three months into normal teeth, difficult to distinguish from the original teeth.

The next stage in this work is the experiment of transplanting embryo teeth to a human being. Dr Lapchinsky and Malinovsky are now preparing for this work.

The experiments of these two doctors afford grounds for the supposition that in a few years the transplantation to adults of the embryo teeth of infants, dying from accidental causes, will become an everyday matter. Three months after transplantation new, young, healthy teeth will develop in the jaw.

Of course the experiments here described are, like the transplantation of the cornea, the first humble steps on the road to the substitution of the organs of the human body. The results achieved, however, permit us to hope for further success. Scientists and experimenters working in this sphere are advancing, slowly but surely, towards the fulfilment of one of the oldest dreams of humanity, the restoration to man of missing parts of his body.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

A Method of Estimating Variance of Sample Grand-mean and Zone Variances in unequal nested Sampling

In nested sampling the fundamental problem is estimating the error of the sample mean. This error is an expression involving all the zone-variances which are unknown. The mathematical expectations of the known variances from Analysis of Variance table are linear functions of these unknown ones. These linear functions have been found and the problem solved for most generalized case with unequal sampling in each zone.

Any sample in a w -fold nesting is represented by $X_{i_1 i_2} \dots i_w = A + {}^1B_{i_1} + {}^2B_{i_1 i_2} + \dots + {}^w B_{i_1 i_2} \dots i_w$ where A is a constant and for $1 \leq K \leq w$

- (1) i_k goes from 1 to ${}^k N_{i_1 i_2} \dots i_{k-1}$
- (2) $E \{ {}^k B_{i_1 i_2} \dots i_k \} = 0$
- (3) $E \{ {}^k B_{i_1 i_2} \dots i_k \}^2 = \sigma_k^2$
- (4) $\sum_{i_p} \sum_{i_{p+1}} \dots \sum_{i_{k-1}} {}^k N_{i_1 i_2} \dots i_{k-1} = {}^k N_{i_1 i_2} \dots i_{p-1}$
 $(1 \leq p \leq k-1)$ and ${}^k N_{i_1} = {}^k N$ say.

Typical term in analysis of variance will be $S(X_{i_1 i_2} \dots i_k - X_{i_1 i_2} \dots i_{k-1})^2$ which is "sum of squares between Z_k -zones within Z_{k-1} -zones" and its corresponding degrees of freedom and variance being f_k and V_k respectively.

Then, for $1 \leq k \leq w-1$ and $0 \leq i \leq w-k-1$

(1) The variance of the sample grand-mean will be

$$\sum_{k=1}^{w-1} \left[\frac{\sigma_p^2}{\omega N^2} \sum_{i_1} \sum_{i_2} \dots \sum_{i_k} ({}^w N_{i_1 i_2} \dots i_k)^2 \right] + \frac{\sigma_w^2}{\omega N}$$

(2) Mathematical expectation of $V_k f_k$ will be

$$\sum_{i=0}^{w-k-1} \left[\sum_{i_1} \sum_{i_2} \dots \sum_{i_{k+1}} ({}^w N_{i_1 i_2} \dots i_{k+1})^2 \left\{ \frac{1}{{}^w N_{i_1 i_2} \dots i_k} - \frac{1}{{}^w N_{i_1 i_2} \dots i_{k-1}} \right\} \sigma_{k+1}^2 \right] + \sigma_w^2$$

Further work on estimation based on maximum likelihood method is proceeding.

The problem has previously been tackled by Messrs S. N. Roy and K. Banerjee¹ where they gave the results in case of equal sampling within each fold, and by Mr W. G. Cochran² where he published the result in case of unequal sampling in a 2-fold nesting.

The problem tackled here concerns the case of unequal sampling within each fold. I had taken up the above study in connection with work on nested sampling under the direction of Prof. P. C. Mahalanobis in 1940 while I was working in Statistical Laboratory.

Mohonlal Ganguli

Calcutta, 6-5-1941.

¹ SCIENCE AND CULTURE, 6, 189, 1940-41.

² Journ. Am. St. Ass., 34, No. 206, 1939.

Synthesis of Pyrene and Derivatives

A new synthesis of pyrene which will be an useful supplement to the existing methods¹ is described below.

Diethyl cyclohexanone-2-carboxylate-2-acetate (b. p. 168°-175°/11mm.) obtained from ethylcyclohexanone-2-carboxylate and ethyl chloroacetate is transformed by boiling alcoholic sodium ethoxide into ethyl 6-carbethoxy-cyclohexanone-2-acetate (b. p. 169°-70°/5 mm.), the mechanism being obviously alcoholysis and ring closure in a new position. A second acetic acid residue is then introduced in the usual manner to yield diethyl 6-carbethoxy cyclohexanone-2 : 6-diacetate (b. p. 190°/4 mm.). This ester on hydrolysis yields cyclohexanone 2 : 6-diacetic acid (m. p. 188° crystallised from a mixture of ethyl acetate and petroleum ether). It is esterified and treated with phenyl magnesium bromide when diethyl 1-phenyl cyclohexanol-2 : 6-diacetate (b. p. 205°-5°/3

mm.) is obtained. The above ester on dehydration and dehydrogenation yields diethyl diphenyl-2: 6-diacetate. Diphenyl-2: 6-diacetic acid (m. p. 168°, crystallised from dilute alcohol) obtained on hydrolysing the above ester yields a gummy product on ring closure. This on Zn. dust distillation yields pyrene, identified through its picrate.

For the synthesis of methyl pyrenes the intermediates diethyl-4-methylcyclohexanone-2: 6-diacetate and diethyl 5-methylcyclohexanone-2: 6-diacetate have been prepared in the following way:—

Diethyl 4-methylcyclohexanone-2-carboxylate-2-acetate (b. p. 165°/5 mm.) obtained from ethyl 4-methylcyclohexanone-2-carboxylate and ethyl chloroacetate is transformed by boiling alcoholic sodium ethoxide into ethyl 6-carbethoxy-4-methylcyclohexanone-2-acetate (b. p. 180°/4 mm.). A second acetic acid residue is then introduced in the usual manner to yield diethyl 6-carbethoxy-4-methylcyclohexanone-2: 6-diacetate (b. p. 202°/6 mm.). This ester on hydrolysis yields 4-methylcyclohexanone-2: 6-diacetic acid (m. p. 184°, crystallised from a mixture of ethyl acetate petroleum). It is esterified when the corresponding di-ester (b. p. 190°/10 mm.) is obtained.

Similarly diethyl 5-methylcyclohexanone-2-carboxylate (b. p. 165°/5 mm.) obtained from ethyl 5-methylcyclohexanone-2-carboxylate and ethyl chloroacetate is transformed by boiling alcoholic solution of sodium ethoxide into ethyl 6-carbethoxy-5-methylcyclohexanone-2-acetate (b. p. 172°/6 mm.). A second acetate acid residue is then introduced to yield diethyl 6-carbethoxy-5-methylcyclohexanone-2: 6-diacetate (b. p. 192°/4 mm.). This ester on hydrolysis yields 5-methylcyclohexanone-2: 6-diacetic acid. It is esterified when the required di-ester (b. p. 190/9 mm.) is obtained.

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Amalendu Bose

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University College of Science
Calcutta, 15-4-1941.

¹ *Monatsh*, 34, 193, 1913.
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